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Contents

Vol.23, No.12; December 2010 www.siliconchip.com.au

SILICON CHIP

Features

11 Soldering SMDs: It's Becoming Unavoidable
SMDs are not going to go away, so if you can't beat 'em, join 'em! Here's a look at the equipment you need to solder the little blighters, as well as standard through-hole parts – by Nicholas Vinen

20 Recycle Your Cordless Drill – Make It *Corded*
Don't throw your cordless drill away when the battery pack dies. Convert it to "corded" operation instead and extend its useful life – by Leo Simpson

Projects To Build

26 A Hot-Wire Cutter With Inbuilt Heat Controller
This hot-wire cutter is just the shot for cutting polystyrene, plastic bottles and polyurethane materials. Its power level is adjustable and it actually melts the material to give a clean, precise cut without mess – by John Clarke

36 Digital/Analog USB Data Logger
Easy-to-build design logs data to a memory card and can read from many different types of analog and digital sensors. It features a real time clock calendar (RTCC) and a USB port to interface with a PC – by Mauro Grassi

66 Digital Lighting Controller For Christmas Light Shows, Pt.3
How to use the Windows-based sequencing program to choreograph your Christmas Lights display – by Nicholas Vinen

78 A High-Quality DAB+/FM Tuner, Pt.3
Third and final article gives the driving details and explains the menu system. We also describe how the firmware can be upgraded if a later version is subsequently released – by Mauro Grassi

87 Build A Hearing Loop Level Meter, Pt.2
Here's how to build a calibration coil and adjust the tester so that it gives accurate results – by John Clarke

Special Columns

44 Serviceman's Log
Hair today, gone tomorrow – by the Serviceman

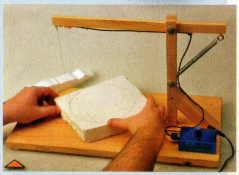
57 Circuit Notebook
(1) Using The LM335Z For Temperature Measurement; (2) Dual Motor Control Circuit For Robotics Applications; (3) Wien Bridge Oscillator Uses Paralleled Op Amps; (4) LEDs & Ladder 2010; (5) Lightning Detector Uses 555 Timer

92 Vintage Radio
The Philco 4-Valve Mantel Set – by Rodney Champness

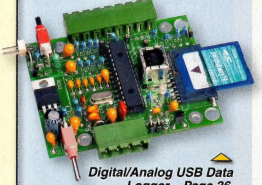
Departments

2 Publisher's Letter
4 Mailbag
19 Order Form
65 Product Showcase
96 Ask Silicon Chip
99 Notes & Errata
102 Market Centre

Recycle Your Cordless Drill – Page 20.



Hot-Wire Cutter With Inbuilt Heat Controller – Page 26.



Digital/Analog USB Data Logger – Page 36.

Calibrating The Hearing Loop Meter – Page 87.

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Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Mauro Grassi, B.Sc. (Hons), Ph.D
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan

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Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

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Publisher's Letter

Desalination plants make heavy reliance on technology

Back in July 2009, we featured an article on how desalination plants work, with a particular emphasis on the Sydney desal plant at Kurnell. This plant has been working for over a year now and apparently supplies about 1.5 million homes. And while there was opposition to the plant at the time of construction, it was and is a necessary adjunct to Sydney's water supply, especially as there is no prospect of extra dams being built.

The big drawback of desalination is that it is so energy-intensive. It requires a lot of electricity to make fresh water from sea water – about 5kWh per thousand litres. That is one reason why Sydney residents are now paying more for their water. The demand from the desalination plant has also added to the constant load on Sydney's electricity supplies. However, a growing population requires more fresh water and apart from advocating domestic water tanks for gardening etc, the state government is caught in a dilemma.

Recently, there was a report from Sydney Water on E-coli contamination in the output of the Kurnell desalination plant and as you imagine, this caused considerable consternation. Apparently though, the report was erroneous and the NSW state government was quick to negate the impression that the desalinated water was unsafe to drink.

Unfortunately, that is not the end of the matter. The only way that the safety of the water can be guaranteed is constant vigilance on the part of the operators of the plant and also Sydney Water which conducts rigorous testing on the whole of Sydney's water. There are two reasons for such vigilance. The first is that the membranes used for the reverse osmosis process can fail. While ever they are working perfectly, no contamination can get through.

But why would the seawater be contaminated? Apparently, there is a sewage outfall some 2.5km to the south of the seawater inlet. So while it is unlikely, it is still possible for ocean currents to move contaminated seawater to the inlet for the plant. How could such a situation have come about?

The sewage plant in question serves the population of Sutherland Shire and it discharges relatively small amounts of sewage compared to Sydney's deep water sewage outfalls at North Head, Bondi and Malabar. As well, the sewage from Cronulla is subject to tertiary treatment compared to the basic primary treatment of the major outfalls. On that basis, the authorities were probably correct in making the judgement that the situation was safe.

However, all the circumstances must always be favourable. First, there can be no failures at the Cronulla sewage plant. This is a pretty difficult requirement, especially since heavy storms in the district could overwhelm the plant, as they sometimes do for Sydney's other plants.

Second, ocean currents must not ever carry sewage-contaminated seawater from Cronulla or any of Sydney's 10 other outfalls to the inlet of the desalination plant. Third, and most vital, Sydney Water must always be rigorous in testing.

It all comes down to technology doesn't it? While it is all working correctly, the water will be OK. But if there are plant failures and human error, those assurances do not apply.

No wonder some people resort to bottled water!

Leo Simpson

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Grid-connected inverters have MPPT

In response to one of your correspondent's query about solar power, as far as I am aware, most if not all grid-connected inverters use MPPT (Maximum Power Point Tracking). In fact, it is said that grid-connected solar power is the most efficient generation of PV power.

I have a 1504W system on my roof and I have seen it generate close to 1600W, which is the limit of my inverter. I have eight 24V 188W panels.

The peak output seems to happen on cloudy days when the Sun suddenly appears. On fully sunny days, the output is lower, with the temperature rise of the panels causing a significant reduction. I seem to get between 1200W and 1300W under those conditions with full exposure. The highest daily output currently (in October) is just under 10kWh per day.

Horst Leykam,
Dee Why, NSW.

Multimeters can lie in valve circuits

With respect to the article on thermionic valves in Vintage Radio (September 2010), there is not a lot of information on the basics of taking voltage readings to be found outside trade teaching and from what I have seen of some of the new generation, not a lot of understanding. It needs to be explained. The article on valves did not and could not be expected to address it; it is a subject in itself.

It should be pointed out that all meters can lie and all meters can blow things up, if the meter is not interpreted correctly, or placed into a circuit where it should not be. Many early Australian radio wiring diagrams (in particular) were extremely vague, although there were some that actually specified the type of meter to be used.

There is scope for an article on "Why Voltmeters Lie" and the ramifications of loading effects caused by the meter. A prime example would be why a 1000Ω/volt meter gives a lower reading on say a voltage divider than a DMM and why this can have ramifications due to misinterpreting the reading. It would also be worthy to discuss errors, like measuring a square wave on an RMS meter and interpreting that.

A comment on the editorial in the September 2010 issue: Has anyone done an energy analysis on the amount of greenhouse gas and resources used to produce and recycle CFLs and incandescent lamps? The metal and glass in a bulb could be recycled and there is no need for plastic in any bit of it.

We might even suggest that the warmth from an incandescent bulb is all the heating some pensioners can afford.

Marcus Chick,
Wangaratta, Vic.

Comment: thanks for your comments about the effects and interpretation of meter readings. This topic was covered in the Vintage Radio column for November 2001.

Your point about recycling of CFLs is also pertinent – we don't know of any analysis on the topic. In any case, we think that it will only be a few years before LED lights take over and CFLs will be remembered as a technology that never delivered on its claims.

By the way, most incandescent lamps do contain some plastic – the

Compressed natural gas has drawbacks as a fuel

I agree with your editorial comment that Australia should use more of its abundant natural gas as a substitute for petrol and diesel fuel used in transport. But having seen both CNG and LNG heavy trucks up close and personal, I concluded both are brutes of systems compared to liquid fuel.

CNG is stored in large carbon fibre cylinders at 350 bar. LNG is stored in a large Thermos flask at -162°C. In an accident, both seem like the Hindenburg on steroids to me. The energy densities are 25% and 60% of diesel respectively, so a lot more volume must be distributed, at a higher cost. The energy to compress and to liquefy are about 1.5% and 25% respectively.

In engines it is much harder to burn NG efficiently than liquid fuel. Diesel engines use about 40% less fuel than spark ignition ones, due to their respective physics. NG can only be used in diesel cycle engines by inducting NG with the incoming air and setting it off with a small squirt of diesel. This is not as efficient or as controllable as liquid injection, with modern systems injecting multiple small bursts of fuels as the piston moves down in the power stroke. Liquid injection is not practical with CNG or LNG.

Therefore, both CNG and LNG are less efficient "well to wheel" and are much more inconvenient and expensive to distribute compared to liquid fuels.

May I suggest that the optimum way to use NG as a fuel (or biomass, shale or coal for that matter) is conversion to synthetic liquid fuel, preferably diesel, and to distribute and use that through existing infrastructure and engines. This would have instant acceptance and cost around $30 per barrel. Plants producing more than 400,000 barrels per day exist in South Africa, Qatar and China, for example – see **http://en.wikipedia.org/wiki/Synthetic_fuel#Projects_under_construction and http://www.chemlink.com.au/gtl.htm**

John Thompson,
Albury, NSW.

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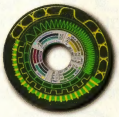

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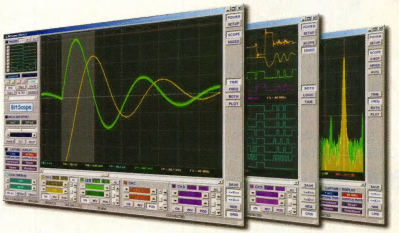

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Mailbag: continued

Solar panels can produce more than their rated output

I can understand P. K.'s confusion about the ratings of solar panels, as stated in the November issue on page 108. I have had to do quite a bit of research to endeavour to get to some of the answers as so much that is said is inaccurate with regards to the use of solar panels and inverters and their respective ratings.

To my knowledge, all grid-feed DC-to-AC inverters use MPPT. I have a 1400W solar panel array and under some circumstances I have obtained nearly 1900W peak input into the mains after the inverter. This puzzled me but I was able to ascertain that at lower than 25°C the solar panels will put out up to around 20% more energy. This doesn't explain the additional 30% more energy that I have obtained at times.

I then read in *Renew* magazine that on cool but cloudy days, with the sun directly on the panels, the refraction or reflection off particular types of clouds will mean more effective sunlight will impinge onto the panels. This in turn means that they give more than their rated output.

Grid input DC-to-AC inverters generally do a good and efficient job of converting the DC from the panels to 230V AC. The European inverters I have seen produce minimal interference, while some Chinese and Australian ones generate horrendous AM and shortwave interference; so steer clear of those. They should meet the various international EMC and EMI standards but the nearest some come to this is the compliance sticker attached to them.

Make sure if you are going to install solar panels that the inverter is electrically quiet and ask the supplier about this matter. I did and was assured that any problems could be solved. I was supplied an Australian one and no matter what was done the interference was horrendous. The cure was the supply of a European inverter.

Solar panels do derate considerably with increased panel temperature and this temperature will be greater than the ambient temperature. Monocrystalline and polycrystalline panels derate at a faster rate than the amorphous panels, which do work better in hotter conditions.

Another thing is that some panels are not of high quality and it seems that the ones P. K. saw at the Perth Caravan and Camping Show were not up to scratch. Additionally, I was talking to a local whose brother imports solar panels directly from China. He brings in 130W panels for under $250 (about $2 per watt) and no doubt sells them for more than $650, which is $5 per watt. It would seem that the solar industry has its rorts too.

Rodney Champness,
Mooroopna, Vic.

thermosetting plastic in the bayonet cap or Edison screw base.

Time delay for electric windows

I'm writing in response to the question about the time delay for electric windows in cars, posed by N. S. of Hamilton, New Zealand (Ask SILICON CHIP, September 2010, page 97).

It's mainly Ford and Holden vehicles that give you a time delay for the electric windows after the ignition is switched off. In Holden Commodores from 1998-2006, the windows will stop a pre-determined time after the ignition is switched off. But instead of turning on the ignition to restart the windows it is much simpler to simply push the unlock button on the remote for the central locking system on the car.

I've travelled in my neighbour's Kia Rio and there is a short time delay once the ignition is switched off but then the key must be inserted to start the windows working again.

Kyle Cogan,
Wangaratta, Vic.

Comment: as you have found, some car makes give you control of the windows immediately the car has been

unlocked but without inserting the ignition key. Others, such as Honda, do not. Some cars will even let you close all the windows and lock the doors with the remote.

So while the ability to use the remote to control the windows may help our original correspondent, depending on his particular make of car, it still does not allow any other way of extending the "power on" period of the windows.

Quad 303 was better than the 405

I read with interest your article/review of the vintage Quad equipment in the August 2010 issue. The results of the comparisons made were not terribly surprising. If I was looking for hifi amplifiers today I don't think you could go past the modern SILICON CHIP designs, plus you get to build the amplifiers (my idea of heaven). They also fit into very nice cases (eg, Altronics), something that was not available 30-odd years ago.

I bought my first Quad 33/303/FM3 system in the late 1960s, replacing it in the late 1970s with a FM4/44/405-2 driving B&W DM6s and a 405 driving a Leo Simpson-designed sub-woofer.

About five years ago I decided some maintenance and experimentation was in order. A web search found enormous amounts of modifications for the 405 and 44, much of it as useful as porting and polishing the ashtrays in your car but there was some gold in the dross.

The main "flaw" with the 405 was always the SOA protection for the output devices (quite fragile components in those days) and the LM301/TL071 op amps (also used in the 44). I recollect SILICON CHIP writing about

Comment on solar installation

In your November 2010 edition, you welcomed comments regarding solar installations. Here are the results of my system for just under 12 months. I have a Fronius 2kW grid intertie inverter (with datalogger) and 2kW of panels. I originally had 1.5kW and upgraded in November 2009. From reading the datalogger, I have found the system occasionally gives over 2kW output.

My general satisfaction with the system is high. The system is producing more power over the year than we use. We also now receive a Gross Feed-In Tariff of 47c per unit (kilowatt-hour). While the savings and feed-in tariff will eventually pay for the system, the main reasons we installed it two years ago are environmental and my interest in solar energy.

I have now heard that simple systems such as mine are now behind the times. Systems that feed in all of the solar power to the grid at 47c per unit and run the house from batteries charged at night from the mains at around 20c per unit are being installed. This pays off the system fairly quickly and it is then all cream. I would be interested in your magazine doing an article on the worth of such a system.

Colin Carpenter,
Mossman Park, WA.

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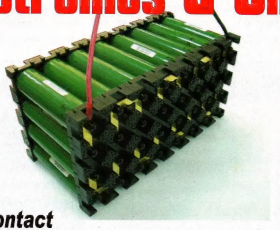

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Irritation with climate change denial

I am renewing my subscription to SILICON CHIP with some reluctance, as I am becoming increasingly irritated with the climate change denials that have appeared in recent times and I think that it's time that you should know why.

Since when does having a qualification in electronics make a person an expert in climate science? Somehow you know more than the United Nations panel on climate change, the Bureau of Meteorology, the CSIRO and state governments – they are all wrong or is it all a conspiracy? Will we be seeing articles on crop circles and UFOs soon as well?

I read SILICON CHIP because it deals with measurable facts of technology, not unsubstantiated opinions based on ideology. By supporting climate change denial in such a way, you only do harm to the credibility of your magazine. By all means have an opinion but stick to your area of expertise, which is electronics.

It is unfortunate that the climate change issue has become politicised when it should be simply accepted and we all get on with our lives and make a few changes, which are not particularly difficult or onerous. Publishing letters and editorials that imply that wind power doesn't work or solar hot water is a waste of time simply makes your magazine look biased and somewhat silly. Sure, it is provocative and generates some mail but it positions you with the fringe dwellers on a serious issue.

Mike Reeves,
Elphinstone, Vic.

Leo Simpson replies: thanks for renewing your subscription, in spite of your irritation with some of my recent editorials. It is true that I have no qualifications in climate science, so why should anyone take any notice of my views? But by the same token, why should anyone take any notice of Ross Garnaut, who is an economist? Or Nicholas Stern, another economist? Or Dr Rajendra Pachauri, chairman of the IPCC, who does not appear to have any qualifications in climate science? After all, we are allowed to question science – that's how progress is made.

More seriously, we should not just accept the views of the IPCC on face value and then adopt major changes to the way we generate electricity, manufacture goods and grow our food, to make what is universally agreed will have no significant effect on the accumulation of carbon dioxide in the atmosphere. As times goes on, such changes will be extremely onerous and the rising cost of electricity will be just one aspect. New Zealand has adopted an emissions trading scheme and its economy is already suffering.

the SOA circuits a year or so ago and after replacing the 405 output transistors with modern/more robust parts and deleting the SOA circuits, you are absolutely right in knocking them; the difference is amazing.

Replacing the op amps with Burr-Brown devices added to the improvement. I must admit to some cosmetic changes, for example deleting all the ageing DIN sockets and completely rewiring the 405s. I ended up with virtually zero DC offset where it had been on average 35mV, an OK number, but the work gave me a great deal of satisfaction.

There are several other worthwhile non-cosmetic mods but I don't think the amplifiers would even now survive a "shootout" with your modern designs. Would I part with my Quads? No.

It's now accepted that the 405 is not a good match with ELS speakers; the 303 or the Quad IIs are much better machines for ELSs. The limiters/jumpers for ELS operation really affect the performance of the 405. Quad even brought out another amplifier for the ELS (the 306, rated at 50W/channel).

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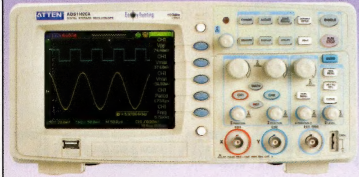

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More simple projects wanted

I have been reading your magazine for many years now and enjoying some of the articles on things like the PICAXE and some of the articles on very basic electronic theory, etc.

However, I now find that it appears to have moved too far away from the basics and is too focused on very complex projects of no interest to me and I would think many others. How about a small return to some of the basics?

Ian Rusch,
Mount Waverley, Vic.

Comment: trying to find a balance between simple and more complex projects is always difficult. If we had more emphasis on simple projects, there would undoubtedly be readers who find insufficient challenge in the articles.

On the other hand, a quick look through recent issues should reveal some reasonably simple projects such as the microphone preamplifier in the September 2010 issue, the TOSLINK/SPDIF converters in the October issue, the Hearing Loop Level Meter and RFID Security system in the November issue and indeed the Hot Wire Cutter and drill recycling story in this issue.

I would even be willing to take the pommie junk and deliver it to the "tip" (here). Alternately I'd be happy to supply the results of my sieving of the dross to the Serviceman or Google *dc~daylight (405 mods)*.

Some of the dross I sieved through related to types of capacitors. Many of the suggested replacement types supposedly perform miracles (after a suitable running in time) but cost a fortune. Some manufacturers now offer "audio grade" capacitors – worth the extra? Should low value (say 3µF) electrolytic capacitors be replaced with MKS/T types?

J. Gibson,
Wentworth Falls, NSW.

Comment: thanks for the comments. In general, replacing electrolytic capacitors with plastic capacitors in audio circuits is of little use, unless the low-frequency cut-off introduced by those capacitors actually has an effect in the audible range.

The point is that where the impedance of the electrolytic capacitor in question becomes significant, at low frequencies, its non-linearity is not likely to be discernible. On the other hand, if these capacitor substitutions are easily made, they won't do any harm and may even do some slight good.

How to make professional front panels

I thought I would inform both you and your readers about some magic material for making professional-looking front panels for equipment.

One of the hardest things to do when making your own gear is to make it look "professional" and this generally comes down to making good-looking front panels. After all, that's the bit everybody sees. You can make the insides as pretty as you like but all that

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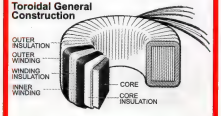

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Mailbag: continued

gives you is the warm inner feeling of a job well done. If the front panel has Dymotape (or similar) stuck all over it, then from the casual observer's point of view, it's just "another bit of homebrew"; nothing outstanding.

I use a product which I source from the USA. It's called "Aluma-jet" and it is available from Horizons Imaging Systems Group in Cleveland, Ohio. The easiest way to get to them is through their website **www.HorizonsISG.com** where there is a lot of information on their products and a method of direct purchase (there don't appear to be any distributors for this product in Australia).

The product I use is a self adhesive-backed inkjet-printable aluminium sheet. This is 0.13mm thick, A4 in size with a satin finish and is coated to accept the ink deposited by inkjet printers. They do supply other thicknesses, finishes and sizes (see the website) but this one works for me.

I use a Canon iP4500 printer which has a (sort of) "straight through" paper path which allows the relatively stiff aluminium to pass through the printing process and give good high-resolution results in full colour. I use CorelDraw (other vector graphic drawing programs are also available at low cost around the traps) to design the panels and then send these designs direct to the printer with the Alumajet loaded. I use the "high gloss" and "high resolution" settings on the printer for best results.

Once the panel is printed, I cut it to size (small guillotine or scissors) and give it a liberal spray of "Plasti-Cote Clear Acrylic" (T-45, available from Bunnings) to give the surface some decent protection. The clear acrylic is fine to use with the inkjet ink and doesn't cause it to "run".

Because Aluma-jet comes with a self-adhesive backing, the backing protection can be peeled off and the aluminium panel applied directly to the job. To make the application easier, a small amount of water with a dash of kitchen detergent can be sprayed onto the adhesive before application. This allows you to adjust the aluminium on the panel for alignment before you finally squeegee out the water (small windscreen squeegee works here) and allow the whole job to dry for a convenient, professional finish. Holes for pots and terminals can be cut out with a sharp knife once the panel has dried and is firmly attached.

The way I started with this technique was to purchase a "Trial Pack" from Horizon and it was only about US$30.00 (plus freight) for five different style sheets to get started. There are directions which come with the pack and plenty of advice on the website.

They also have other products which you can find out about for yourself but another one I do use is Vinyl-jet which is a self-adhesive vinyl sheet product that's also suitable for inkjets. I use this to print circuit diagrams that I stick inside the gear for later servicing and also for back panel labels and so forth. I also use the clear acrylic coating to protect this product.

I trust this will enable home constructors (and maybe some professionals) to produce elegant panels at relatively low cost.

Jeff Thomas, Falls Creek, NSW. SC

Nicholas Vinen takes a brief look at what's available in SMD Hardware. . .

Soldering SMDs: it's becoming unavoidable

If you've been reading SILICON CHIP for a while, you will have noticed that from time to time we publish projects which use surface mount devices (SMDs). We've tried to avoid them where possible because many, probably most, home constructors and hobbyists are at least a little apprehensive about using them. For some, building a project which involves one or more surface mount devices may deter them completely from building the project.

And that's a shame.

The problem is that SMDs are not going to go away – we find we have to use them more and more often. There is a simple reason for that: many newer ICs and semiconductors are not even produced in through-hole packages.

So if you can't beat 'em, we need to help you join 'em!

What are the major problems, apart from the fact that SMDs are (usually) very much smaller than their through-hole counterparts and even people with perfect eyesight often need a magnifying glass or loupe to identify them?

Probably the biggest is that there is definitely less margin for error – due of course to the thin tracks required for parts with close pin spacing. It doesn't take a lot of excess heat to lift tracks off the circuit board and repair can be tricky. Another difficulty is one identical with through-hole semis: too much heat risks damaging/destroying them. But it's easier to apply too much heat with SMDs!

Having said that, if you have a steady hand and some patience, with a bit of practice, dealing with SMDs becomes fairly straightforward. It really helps to have the right tools. In this article we take a look at a selection of tools which make soldering both surface mount and through-hole devices easier and quicker.

This is not the first time that we have written about SMD soldering. Our previous articles have touched on several different techniques suited to specific types of packages, as there are many SMD package types, each of which requires a different approach.

For our previous tutorials see *How To Hand-Solder Very Small SMD ICs* (October 2009), *How To Solder Surface Mount Devices* (March 2008) and *Working With Surface Mount Components* (January 1995).

Those articles covered mainly the "how to" aspects. Here, we are going to look at some of the specialist equipment available. It is by no means an exhaustive list – in fact, much of this article has been generated by various suppliers submitting equipment for review. It seems they too are now firmly hitched to the SMD bandwagon!

Nor are we suggesting that all of this equipment is required by the enthusiast, though all of it can be used by hobbyists (noting the sometimes deep pockets required and also sufficient volume of construction to warrant it!).

But it will give a good idea of the type of equipment that is already being used extensively in industry, service/repair and electronics laboratories in Australia and around the world.

JBC BD-A Digital Soldering Station

"Mini-wave" soldering tip for the T245 handpiece.

Have you heard of JBC soldering stations? We hadn't either and didn't know what to expect. What we discovered is a serious unit with some excellent features.

We only had this evaluation unit for a short period but during that time it quickly became apparent that it is something special.

Like many modern soldering stations it features digital control, which allows the tip temperature to be precisely set and monitored.

Two handpieces are available, the standard-sized T245 and the T210 lightweight, fine tip version. The base station has an LCD display and keypad along with the integrated stand and metal wool for cleaning.

That's all pretty straightforward but when we started using it we made some pleasant discoveries.

Clever temperature management

JBC have designed the heating element and tip in a way which gives two advantages over other models we have tried. Firstly, because the tip is light and has very low thermal mass, it heats up rapidly.

We thought our existing soldering stations were pretty good – they get up to temperature from cold in about 30 seconds – but this one blows them away.

It's so fast that you can switch it on, sit down, grab the board you want to work on and it's ready to go. It goes from cold to 350° in two to five seconds, depending upon the tip used.

That may not sound like a huge advantage since you can always turn your station on and do something else for half a minute.

But if you are like us, there are many times that you just need to replace one component or make some small change on a PC board – and then you might need to do it again in five minutes. In situations like that the time savings can add up.

The second advantage is that there is a sensor in the stand which can detect the presence of the handpiece. As soon as you finish soldering and put the handpiece down, its temperature is lowered to around 220° (this can be adjusted). The LCD shows "SLEEP MODE".

As soon as the handpiece is removed it is brought back up to the working temperature so fast that you need not even be aware it is happening.

This sleep mode function not only saves power but it extends tip life since they oxidise faster when they are hot.

What's more, because the station knows when the handpiece is on the stand, it can keep track of how long it has been since you last used it.

After thirty minutes of idle time (also adjustable) it switches the heater off entirely. This provides great peace of mind in case you accidentally leave the iron on – the tip will be protected and the risk of fire or other damage from a forgotten iron is minimised.

It also means that you can leave the iron switched on for those times when you may be using it intermittently without worrying about when you might next need to use it.

Just a tiny selection from the huge range of tips available for the JBC BD-A.

Multiple tips

Like any decent iron, the JBC BD-A has a large selection of different tips, many of which are designed for use with SMDs.

These include: conical, chisel, knife, angled, spoon (miniwave), notched (for SMD components), U-shaped (for inline ICs), rectangular (for quad flat packs), etc.

A problem we have faced in the past is that changing tips takes some time. First you must switch off the heater element and wait for the tip to cool down, then unscrew the retaining nut, remove it, attach the new tip, tighten the nut back up and wait for it to heat up again.

This process can take a frustratingly long time, making jobs which require many different tips (eg, building a board with a mix of SMD and through-hole components) difficult. One solution is to use multiple soldering irons but obviously this is not ideal.

The BD-A solves this entirely with a very clever tip attachment scheme. The stand has three "parking" locations for tips built into its base. While the iron is still hot, you can place the tip in an empty slot and then pull down and back. This extracts the tip, leaving it in the slot. The handpiece can then be pushed down onto another different tip in another slot and once it's in, it heats up rapidly.

The removed tips cool down quickly too, so you can take them out of the stand and swap in another virtually straight away.

This is an invaluable feature for working on surface mount or mixed boards, where you might be switching between several tips frequently: a fine one for small components, a larger one for big components, a wave tip for multi-pin devices, a notched tip for soldering chip resistors and capacitors and so on.

Other options

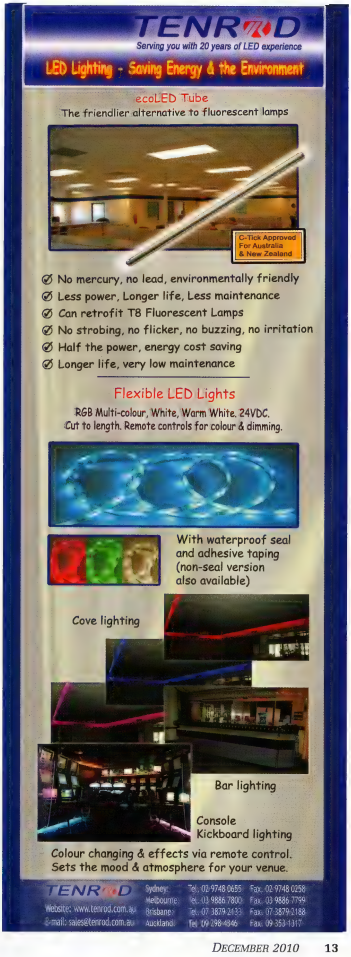
The options for this iron are comprehensive. There is a third handpiece style which is identical to the standard T245 but with a heat shield for extra comfort during long sessions. Also available is the T245-NA handpiece with nitrogen nozzle and a fume extractor.

The station itself is available in several versions. The DD-A is a dual station which accepts two handpieces and the DM-A is a quad version. JBC also make stations with automatic solder feed and vacuum for desoldering/reworking.

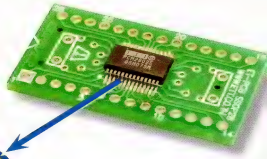
Price and availability

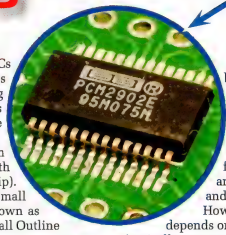
The JBC BD-A has a two year warranty and is available with either the T245 or T210 soldering handpiece for A$614.50+GST. Get it from Mektronics (www.mektronics.com.au). Additional handpieces cost A$122.29+GST or A$163.06+GST with the comfort grip.

Orders can be placed via their web site or call 1300 788 701 (or, in South Australia (08) 8346 0333). For more information e-mail sales@mektronics.com.au



Manual Wave Soldering





Hand-soldering fine-pitched SMD ICs can be a challenge. But it is sometimes necessary, typically when repairing commercial equipment or assembling boards which use ICs not available in through-hole packages.

For surface-mount chips with larger pin spacings, hand-soldering is possible with a regular iron (made easier with a fine tip). Examples of such IC packages include Small Outline Integrated Circuits (SOIC) also known as Small Outline Package (SOP), SOT-223 (Small Outline Transistor type 223) and D-PAK (TO-252).

Other packages are hard to hand-solder with a regular soldering iron. Common such types include Shrink Small Outline Package (SSOP), Molded Small Outline Package (MSOP), Thin Shrink Small Outline Package (TSSOP), Thin Quad Flat Pack (TQFP), Quad Flat pack No leads (QFN) and SOT-23 (Small Outline Transistor type 23) variants.

We hope you have studied all those initials – there will be an exam later . . .

With practice and special techniques SMDs can be reliably soldered with a regular iron but there are easier ways.

Those who work frequently with fine-pitch SMDs prefer using special tools that make the job a lot easier.

One inexpensive tool is the "mini-wave" soldering tip or spoon tip. This is essentially a regular chisel tip with a semi-spherical depression in the otherwise flat face. When solder is melted in the depression, it stays there due to surface tension.

At this point we should pause and explain the name. Wave soldering is one of the two major means of large scale PC board assembly (the other is infrared reflow). This involves a large solder bath which is kept liquid. In it, a series of waves are created.

Each board is passed over the bath and the tips of the waves touch its surface, to which flux has already been applied. The surface tension of the solder causes a small amount to adhere to the pads and pins of each package – just enough to make a solid electrical and mechanical connection.

The advantage of wave soldering compared to reflow is that it works well for both surface mount and through-hole components.

What does this have to do with the manual wave soldering we are about to describe? Not a lot, except for the fact that the solder surface tension is an important part of both processes. Essentially, the movement of the soldering iron across the IC pins has the same function as the solder wave.

In use, first the IC is tacked down (usually by hand-soldering at least two corner pins), then a layer of flux paste is spread over the rest.

The next step requires a bit of practice but isn't too hard once you get the hang of it. With some fresh solder in the depression, the tip is placed against the first pin and dragged along that row. This vapourises the flux which allows the solder to flow freely. Surface tension pulls exactly the right amount of solder out of the depression and onto each pin.

How quickly the soldering iron is moved depends on the exact flux and temperature used (typically 260-280°). It is easiest with a viscous flux that does not vapourise quickly - and in that case, a slow and steady motion is best. With faster vapourising flux, the motion of the iron must be quick but smooth. The flux we used boiled fast so it took us a couple of tries to get the timing right but once we did, it all went smoothly.

The photo shown here is an IC we soldered using this technique. It is a 28-pin TSSOP package and the whole procedure from start to finish took about 30 seconds and resulted in no bridged pins. If one or two were bridged then all it would take is a little flux and some solder wick to clean it up.

Here's a handy hint: if you are right-handed, tack the IC down using the upper-left and lower-right pins. If you are left-handed, tack it down using the other two pins. This is important because it is easiest to drag the iron starting at the top of the IC in your primary hand. If you tack the IC using the wrong pins then it will move when you apply the iron, resulting in a skewed solder job.

Mini-wave soldering tips are not available for all irons but most major manufacturers make them for their higher-end models. We used a JBC tip with the JBC BD-A soldering station provided to us by Mektronics.

Hakko also make mini-wave tips (type ETGW or BCM/CM) but not for all their models – we are out of luck with our FX-888. There are mini-wave tips available for Hakko models FX-950, FX-951 and FM203.

www.hakko.com
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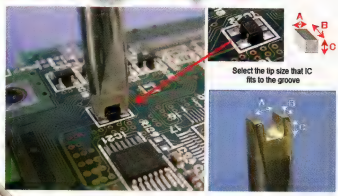
SMD Soldering Tips



(Above): while most commonly used when working with passive ("chip") components, these tips can also solder small ICs. In this case, it is an SOT-23-5 package. There are interchangeable tips like these available to suit most of the better soldering stations.

(Above left): Altronics all-in-one "tweezer" SMD iron, where both tips are heated allowing both sides of an SMD device to be soldered at once.

Both these devices do roughly the same job, although the tweezer-type iron doesn't require a change of tips for different devices.

Passive surface mount components such as resistors, capacitors, inductors etc can be soldered in place one pin at a time.

However, removing them is much more difficult because the wide, flat pins do not have much "give" and it is virtually impossible to remove enough solder from each pad to get the component free.

The obvious solution is to heat all the pads at once but that is difficult with a regular soldering iron.

One solution is to use an SMD "tweezer"-type soldering iron handpiece like the Altronics T2461 (see photo above) which essentially has two tips with an adjustable gap between them.

Alternatively, you can buy special forked tips for some regular handpieces. The notch in the middle is sized for specific surface mount components case sizes. Typical sizes are imperial 0603 (1.6 x 0.8mm), 0805 (2.0 x 1.2mm) and 1206 (3.2 x 1.6mm) and many manufacturers (eg, Hakko, Micron, JBC) make tips suitable for each.

These are also suitable for soldering small surface mount ICs, such as those in SOT-23-5/SOT-23-6/MSOP-6 packages, as shown in the photo (above right). The tip shown here is from Hakko. This shape is available across a wider range of their models than the mini-wave tip mentioned earlier.

Buying a selection of such tips tends to be much more affordable than purchasing specialised surface mount soldering tools. One challenge with using them is that if there is enough solder on the component, sometimes it can stick to the soldering iron when lifted off the board. In these cases, the component can be removed using tweezers.

It is even possible to get specialised tips for soldering/desoldering larger surface mount ICs, including quad flat packs. These are made from a metal sheet which is folded to provide a contact area for each row of pins. While they tend to be trickier to use than hot air rework stations for desoldering, they can come in quite handy for soldering replacement ICs in place.

• www.altronics.com.au

An SMD tweezer handpiece which plugs into a soldering station. These are more expensive than the Altronics iron (above) but they are slimmer and lighter, making it easier to work with smaller components and on crowded PC boards.

Photo: Aisart, Wikimedia Commons.

Micron T-1260 Vacuum Desoldering Tool

Most readers will be familiar with "solder suckers" – the hand-driven vacuum pumps used for component removal. Pressing the plunger compresses a spring and it latches in place. When the release button is pressed, spring force pushes the diaphragm up through the cylindrical chamber, generating suction at the tip. If the tip is against molten solder when the plunger is released, much of the solder is sucked into the chamber – hopefully enough to free the component lead.

While solder suckers are cheap and can be used to remove many types of components, they have several disadvantages. Firstly they require dexterity to use properly, as the tip must be placed accurately against the molten solder and the plunger released in quick succession, otherwise the solder will not be completely sucked away.

Due to the limited amount of suction available, it can take multiple tries (and possibly also the use of other tools like solder wick) to get the lead free of the board, especially on boards with plated through-holes. Reliably removing multi-lead components without destroying them can be difficult. You also need to regularly clean the chamber and tip, otherwise over time the suction drops. The diaphragm needs to be re-oiled after cleaning or else the seal will eventually fail. The plastic tips also need to be replaced periodically.

Having said all that they are still a very handy item in the electronics toolbox. But what do you do if you need to regularly and reliably desolder components? The answer is a powered vacuum desoldering tool such as the Micron T-1260 from Altronics.

We actually purchased this unit, thinking it would come in handy occasionally – but now we use it frequently because it's so much more convenient.

Usage

The most important improvement over a solder sucker is the fact that the vacuum tip is heated. Basically, it is a soldering iron with a hole though the middle. The T 1260 is temperature controlled but it also has a lot of thermal mass, which can be an advantage when removing large components or those mounted on copper planes. However, it takes a few minutes to come up to temperature.

The temperatures used are a bit higher than typical for soldering, generally in the range of 350°-425°. This is because desoldering involves melting solder where most of the flux has already boiled away and the solder must flow properly so that it can be removed.

For small components such as resistors, signal diodes, low power transistors etc, the tip is placed over the lead stub, as perpendicular to the board as possible. The solder around the lead melts instantly and then it is just a matter of a quick squeeze of the trigger to suck it away.

It works so well that components will sometimes fall out of the board under the pull of gravity, occassionally even on boards with plated holes. For stubborn components on such boards it is sometimes necessary to repeat the process or give a gentle pull with some pliers before the leads come free.

The solder is sucked into a chamber behind the tip which is filled with steel wool and a felt-like plug. The steel wool traps virtually all of the solder and it is very easy to dispose of. Inevitably some of the wool is thrown away with the solder but luckily replacing it is very cheap and easy – the contents of the original filter provided is identical to fine steel wool from the supermarket.

The handpiece is a pistol-grip type as opposed to most soldering irons which use a pencil-style grip. As it turns out, the handpiece suits the way in which the tool is typically used, with it in one hand and the board held in the other.

This is an invaluable tool for an electronics lab, saving a lot of hair-pulling when making many changes to a prototype circuit.

- www.altronics.com.au

Hot Air Rework Stations

With the proliferation of surface mount devices, hot air rework stations are vital for today's service industry. These combine a temperature-controlled soldering iron (usually with a fine tip) and a hot air gun with adjustable air-flow and temperature and a selection of nozzles with different shapes. Shown here is the Jaycar rework station (TS1574).

Some nozzles are cylinder shapes of varying sizes while others have two or four slits arranged in a parallel or rectangular configuration, again in various sizes. These suit the pin layouts of various SMD ICs and are used to heat the IC leads directly without damaging the chip or nearby components.

With a hot air rework station and some practice, desoldering a fine-pitched IC is easy. Flux paste is applied along the pins and the appropriate nozzle is installed on the air gun. The air temperature and flow are adjusted to suit the size of the IC and the thickness of the board.

Then it is just a matter of gently heating the IC leads until the solder melts and the flux begins to boil. At that point (assuming it's not glued to the board) the IC can be lifted off leaving virtually clean pads. If required, what little solder is left on the board can be picked up with more flux paste and some solder wick.

The technique for soldering an IC using a hot air rework station is similar to that used with a reflow oven. A thin layer of solder paste is applied to the pads and the IC is placed on top. It is then just a matter of clamping it down (so that the airflow can't blow it out of position) and applying heat using the same nozzle until the paste melts and flows onto the pads.

The main trick in both cases is getting the air temperature and flow rate correct. Too high a temperature or too low an air speed can cause localised excessive heating on the PC board, resulting in a singed board (it smells bad!) and possibly also component damage. As with manual wave soldering, some practice is required but once you get the hang of it, the procedure becomes routine.

The Jaycar TS1574 station is supplied with three nozzles; eleven types are sold as accessories. They also stock four different types of tip for the integrated soldering iron.

• www.jaycar.com.au

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Hakko FX888

General purpose soldering iron

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- Lead or lead-free solder
- Excellent thermal recovery
- With tip conical shape T18-B, cleaning sponge and wire

Hakko FX951

Advanced lead-free soldering iron

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- With sleep mode, auto shutdown, lock out card, quick tip replacement.

Hakko FR803B

Hot Air SMD Rework Station

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- Vacuum pickup
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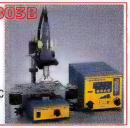

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ChipQuik SMD Removal Kit

Surface mount ICs can generally be removed without special tools. One technique involves applying solder generously to each row of pins, then heating each in turn with a hot iron. Eventually enough of the solder stays molten that the IC can be lifted off the board. The solder left behind on the board can then be removed with a vacuum tool and some solder wick.

The problem is that this is very messy and it risks damage to both the board and IC from excessive heat. It is especially difficult if other components are mounted right next to the IC. Because the solder tends to "bead" at high temperatures you have to use a lot of it.

Now there is a better solution.

"ChipQuik" makes it much easier to remove surface mount ICs (or other multi-pin devices) with a standard soldering iron. It also works with some through-hole components.

Essentially, the ChipQuik kit contains a special solder alloy with a low melting point and high thermal mass. It can be purchased on a reel like regular solder or in short lengths, as shown here as part of the kit. The kit also includes a syringe of no-clean flux paste and alcohol swabs. The flux paste and alcohol swabs can also be bought separately in larger quantities.

The advantage of "no-clean" flux paste is that, since it is not corrosive (like some fluxes), it does not need to be cleaned off the board after use.

This kit is available from Jaycar (Cat No NS3050) and Mektronics (QCSMD1). The package states that it contains enough product to desolder 8-10 ICs but the exact number will depend on just how large and how many pins the ICs have – we estimate that for hobbyists it will actually last longer than that.

The technique used is similar to that descibed earlier. First flux paste is applied to the IC pins, then the ChipQuik solder is spread along them. Because it stays molten so much longer than regular solder, repeated heating is unnecessary and the overall temperature can be kept lower. Once it has been applied and heated, the IC comes off straight away.

Solder wick and the supplied alcohol swabs can then be used to clean off any remaining ChipQuik or regular solder from board so that a new IC can be installed.

A demonstration video can be viewed at www.youtube.com/watch?v=FTQqjggeklo

This product is a good solution for those who only occasionally need to remove a surface mount IC. You would have to do so quite regularly to justify the much higher cost of a hot air rework station.

If you would like to purchase ChipQuik solder in larger quantities, Mektronics sell it in "industrial pack" (CQSMD4.5) as well as the flux paste (CQSMD291AX) and a solder paste equivalent (CQSMD291SNL).

- www.jaycar.com.au
- www.mektronics.com.au

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Here's a great green idea – especially if you want to do work around the car or boat!

Recycle your cord drill – make it c

Handyman cordless drills are very cheap – most readers probably have at least one or two in their tool collection. But their big weakness is the battery pack and associated charger. What do you do when the battery pack dies? Just convert the drill to corded operation. It's a simple conversion and ideal for working close to 12V power.

Back in the December 2006 issue we had a feature article on repacking the battery pack in cordless drills whose batteries had died (or were at least very sick!).

The idea was to buy a ten-pack of sub-C 1.8Ah nickel cadmium cells and simply pack 'em into the battery pack.

It is not rocket science – just follow the steps in the article. But there was a catch – there generally always is.

In most cases, if your battery pack had a short life it was probably because the charger was a rudimentary design, perhaps not much more than a small transformer, diode rectifier and a charge limiting resistor. These chargers – and they are extremely common with cheap cordless drills – spell early death for the battery pack. They have no proper "end-of-charge" circuit cut-off or timer to prevent over-charging.

So, as well as the article on repacking the battery pack, we presented a proper charger – the Power Tool Charging Controller – also in the December 2006 issue.

This charge controller was designed to go between the existing rudimentary charger and the battery pack. It was based on a PIC microcontroller and incorporated adjustable timer, temperature cut-out and dT/dt sensing for correct end-of-charge cut-off.

Fast-forward to December 2010 and everything we wrote four years ago is still valid and even the cost of a ten-pack of the same sub-C nickel cadmium cells is still the same.

A new set of NiCads is likely to be around $70 or more and you need to add the cost of building the Power Tool Charge Controller which might be around $30 or more. Total cost is going to be at least $100 and that is the outstanding reason why so many cordless drills end up in the garbage bin or just gather dust on a shelf in the workshop. It's a shame though, since the drills are probably capable of many more years of work.

What about replacing the battery?

Just go to eBay and you will find that there are now a lot of battery packs available. They're not particularly cheap though, especially when you add in the cost of postage. And good luck in finding one that suits ***your*** particular drill.

Even if you do find one, the cost of a new battery pack may well be just as much as (or even greater than!) the cost of a brand new, more modern drill kit, often including ***two*** batteries, from your local hardware store.

One thing hasn't changed though. If your charger is one of those rudimentary designs, you still need to build our Power Tool Charging Controller. And while the kit is no longer available from Jaycar, the design is still valid and you can get all the bits.

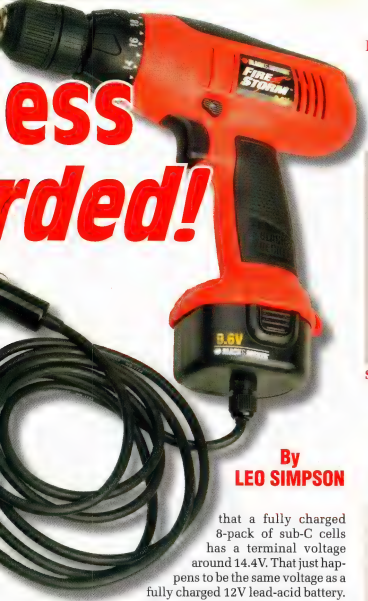
An easier fix!

But why bother with all of the above? Why not just convert the drill to "corded" operation? This way, you avoid the cost of repacking or replacing the battery pack.

Just recently one of our staff members was faced with the same conundrum – his cordless drill battery pack had died – so what to do with it? It was a 9.6V drill and superficially, that means there is no easy battery/cheap replacement.

But let's think about that. A 9.6V battery pack means that it contains eight nickel cadmium or nickel metal hydride sub-C cells rated at 1.2V each. Hmm.

When those sub-C cells are fully charged, they will have a terminal voltage up around 1.8V or thereabouts. That means



By LEO SIMPSON

that a fully charged 8-pack of sub-C cells has a terminal voltage around 14.4V. That just happens to be the same voltage as a fully charged 12V lead-acid battery.

So why not run a 9.6V cordless drill from a 12V battery or power supply? Why not indeed!

Now admittedly, a fully charged 9.6V nickel cadmium battery pack will not stay at 14.4V for very long. In fact, as soon as you start to do any work with the drill, the pack will quickly drop to 9.6V or thereabouts.

But the point is that the drill motor itself and its internal speed controller will have (hopefully!) been designed to take supply voltages up to at least 14V. It will probably cope with more than that – say up to 16V or more although power dissipation is likely to be a problem if you start to use the drill for heavy work for more than brief periods.

Before we go into the details of this straightforward conversion, let us state from the outset that it works well and the drill itself probably works better than with the original battery pack.

Nor does the conversion need to be confined to drills rated at 9.6V. It can certainly be applied to drills rated at 12V, 14.4V or even higher if you have a suitable DC power supply – we'll discuss the details later.

Similarly, there is no reason why you cannot run an 8.4V drill at 12V; seven nickel cadmium cells fully charged will provide a no-load voltage of more than 12V.

However, we would be hesitant to run lower voltage drills (ie, 7.6V and below) at 12V.

DOING THE CONVERSION:

Step 1: Pull the battery pack apart. This is usually pretty easy and involves removing four Philips head screws and this gives access to the sub-C cells which are typically arranged in a circular array with at least one or two other cells on top, all with their tab connections spot welded together.

Step 2: Identify the internal connections. The negative end of the battery pack, one of the sub-C cells, may be spot-welded to one of the terminals which make internal contact with the drill circuitry.

The other end of the battery pack will connect via a short wire to the other terminal which makes contact with the drill circuitry. So before you start ripping out the sub-C cells, your second step is to identify how the connections are made.

Step 3: Remove the outside array of cells from the central one or two cells. In our case, we left one cell connected to the main connection terminals, since it was spot-welded.

Step 4: Drill a 12mm hole in the centre of the battery pack case. This hole takes a 6.5mm IP65 cable gland which will clamp the new power cord. Don't rush this step. Unless you have a drill press which can provide low speed settings of no more than, say, 400 RPM, you will need to drill the hole in several stages. In fact, even though we do have such a drill press, we used a succession of drills to do this task. Alternatively, you can start with say, a 5mm drill and then expand the hole to the right size with a tapered reamer.

Step 5: Install the 6.5mm cable gland. It mounts from the outside with a nut holding it in place on the inside.

Step 6: Prepare a suitable length of flexible double-sheathed 2-core power cable for the drill. You need to decide how long you want this power cable to be. If you want to use it powered from the cigarette lighter socket in your car, you will want the cable to be three or four metres long. A shorter cable will mean that you are too closely "tethered" to the lighter socket.

Err on the side of making the cable longer – you can always shorten it at a later date if you find it is too long.

We recommend that you use Cat WB-1754 flexible 2-core cable from Jaycar. They describe it as speaker cable but the flexibility and the current rating is what we want for this job. It has red and black wires to make + and – identification easy. If you have a suitable length of 2-core double-sheathed 250VAC cable rated at 7.5A or more, that will also do the job but it probably won't be quite as flexible as the suggested speaker cable.

If you're using mains cable, it makes sense to use the brown wire as + and the blue as –; in any case, make a note of which wire you connect to the centre terminal of the plug.

Why? Because if the DC supply to your drill has the wrong polarity, it won't work. Worse, you might burn out the internal speed control. We will come back to this point later.

Step 7: Strip and terminate one end of the power cable in a standard cigarette lighter plug – Jaycar Cat PP-2000 or equivalent. Make sure you terminate the red wire to the centre terminal of the cigarette lighter plug.

Step 8: Strip and solder tin the two wires at the other end of the cable. Pass this end through the cable gland and leave about 15cm slack.

Step 9: You need to work out how to make the wire connections to the 2-way connector of the battery pack. In our case we left one of the sub-C cells connected to the connector – since it was spot welded to the can.

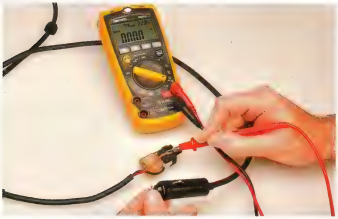
Now there is an important point here. Since the

can of the sub-C cell was connected to one of the battery pack connectors, this was the negative side of the battery pack supply. Hence the negative wire of the 2-core power flex needs to connect to the same point.

Fortunately, with a well-tinned and good, hot iron we found that we could solder directly to the can of the sub-C cell. If you cannot do this, you will have to devise some other method of making a reliable connection.

It's also important that you don't connect both of your wires to the "dummy" cell – even dead, it will attempt to charge (very rapidly!) when connected to 12VDC and the heat could cause damage; perhaps even a fire. Break one of the connections between the cell and battery connector.

Step 10: Check your connections. Make sure that the central terminal of the cigarette lighter plug connects to the correct terminal in the battery connector.



Step 11: That done, reassemble the battery pack with its Phillips head screws.

In our case, we found that we need to ensure that internal connections were actually held into the drill's connector when the battery pack was clipped into place. The best way to achieve this was to leave the dead cells in place. If you don't that, you would need to make up a suitable packing piece. So as noted at the start, we removed the central cell from the array of cells around it. This allows space for the inside portion of the IP65 cable gland and the cable itself. The photos tell the story.

Step 12: Use an adjustable DC power supply to check operation of the drill. Start out with a low voltage setting, say 6V. If you drill has variable speed control (most have), use the drill's trigger control to check that it will vary the drill speed. In order to do any real work with the drill, your power supply will need a rating of at least 10A.

Power supply options

You have a number of options for powering your modified no-longer cordless drill.

First, you can run it from the cigarette lighter socket in a car or boat. Note that some cars these days do not have a cigarette lighter socket, or if they do, it is termed an "accessory socket" and it may only have a light-duty fuse, say 3A rather than 30A. The modified drill will blow the fuse in an accessory socket and we would caution against increasing the fuse rating unless you know the harness wiring to the socket can take high currents.

Note that the peak current of the drill, when first switched on or when it is stalled (say when driving screws) can easily exceed 20A. Another point to note is that most of these cordless drills short out the internal speed control when you pull the trigger all the way in. So if you want to avoid the initial switch-on surge, squeeze the trigger smoothly rather than jerk it fully in.

Your second option is to connect the drill directly across a 12V battery, either a car unit or an SLA battery rated at 9Ah (amp-hours) or more. Either way, you have to be very careful of polarity, otherwise you will definitely blow the speed controller in the drill. In fact, if you are going to use this method of connection (rather than a cigarette lighter plug), then you would be well advised to connect a 20A Schottky diode in series with the positive lead. This can be installed inside the battery pack.

Another point to consider if you are using a 12V SLA battery is that you must not discharge it below 11V. If you do, the battery will not be able to be recharged.

Third, if you have 12V lead-acid battery charger rated at 10A or more, that could also be pressed into service.

Finally, you could also modify a discarded PC power supply to run your drill. We will show how to adapt such a PC power supply in a future issue.

Summary: suitable power supplies

- Car cigarette light socket (fused to 30A)
- Boat cigarette lighter socket (fused to 30A)
- 12V SLA battery rated at 9Ah or more
- Adjustable power supply able to supply at least 10A
- 12V lead-acid battery charger rated at 10A or more
- Ex-PC power supply – able to to supply at least 10A at 12V ("XT" supplies usually easier to use than "AT").

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dick smith
Talk to the Techxperts

HOT WIRE CUTTER

WITH INBUILT HEAT CONTROLLER

If you've ever tried to cut polystyrene (especially!) and polyurethane materials using a saw, razor blade or knife, you'll know that the results are invariably less than satisfactory. If you are after a clean, precise cut, a hot-wire cutter is the answer. The hot wire actually melts the material and results in a very neat, very fine cut, without the thousands of bits of foam flakes you normally get.

by John Clarke

For modelling, hobby and furniture upholstery work, a hot wire cutter is a must-have.

No more material deformation, no more jagged edges and crooked cuts, no more beads of polystyrene broken off and flying about – and the cut is so much more accurate into the bargain.

But wait, there's more: this SILICON CHIP Hot Wire Cutter includes a controller to allow the wire temperature to be adjusted to produce a clean cut regardless of the thickness or even the type of material being cut.

It suits a variety of low-melting-point "thermoplastics" but with polystyrene it really comes into its own.

There are two common forms of polystyrene – the beaded type, popular as packaging material and as the "beans" inside beanbags.

When all those beads of polystyrene are extruded into a block, we get the type of "foam" we're so familiar with. Extruded polystyrene has an enormous variety of uses. It's widely found in consumer goods packaging, it's used in modelling, it forms the basis for surfboards and other floating aids and is used as an insulator – sometimes on its own but more often "sandwiched" between two tougher materials, as on its own it's quite brittle.

Believe it or not, the letters in the photo above were actually cut (using our new Hot Wire Cutter, of course!) from offcuts of 50mm-thick Polystyrene foam used as part of the cladding on the home of one of our staff members.

Polyurethane, at least in the form we are talking about, is often called "foam rubber", though of course there is no rubber in it.

Its most common usage is for padding in furniture and even car seats. It's also shaped into many products such as bedding underlays. In its "crumbled" (or crumbed) form it too is used extensively as a packaging material.

Both types of plastic have a relatively low melting point of around 170 - 240°C and both are delightfully easy to cut with a hot-wire cutter.

Other types of plastic that could be cut with a hot wire cutter include PET (eg, soft drink bottles), ABS (eg, "plastic" cases and parts) and clear or coloured Acrylic or Perspex.

We'll have more to say about cutting these different plastics later.

Our hot wire cutter design

Hot wire cutters are relatively simple and comprise a frame that supports a length of heated resistance wire which is kept taut by some form of spring. The wire needs to be taut so that the cut is straight and the wire does not bend while cutting the material. Tensioning is also required to maintain wire rigidity, as the wire expands when heated.

A power source is required to provide the energy to heat up the wire. This can be sourced from a battery, or via a low voltage supply derived from the mains. Previous tests show that you need up to 100W per meter for cutting polystyrene and polyurethane.

(You might remember an earlier hot wire cutter, published in the April 2000 issue. This one is more elegant and has its own variable power supply

so it is much more versatile when it comes to material to be cut.)

Ideally, a means to adjust the power applied to the wire is necessary so that the wire temperature is correct. If too high, it can cause melting or burning of the material and ultimately the melting (and eventual snapping) of the cutting wire. If too low, the material will not melt and therefore not cut and the cutting wire will be strained.

The power is adjusted to give the best cut for the type of material without too much curling at the cutting edge. The heat setting also sets the rate at which the material can be fed through the cutter. Again, if it is too low, the material needs to be pushed harder to cut and this too may cause the cutting wire to break.

Refinements to this cutter include a plinth and adjustable edge guide so that sliding along this straight edge can cut the material straight. Some cutters include automatic feed so that the cut is consistent along the length.

When feeding by hand, any hesitation in feeding the material will cause excess melting. Feed the material too fast and the wire will tend to bow. The bowing is caused by the wire's inability to melt the material at the rate that the material is fed and hence cutting is slowed or halted. The solution is to feed the material more slowly or to increase the power fed to the wire. It's wise to practise on pieces of scrap material before trusting your skill on real work!

Our cutter is a hand-fed unit suitable for hobbyists making models and general plastic cutting. The actual size of the cutter depends on the size of material that needs to be cut. For upholstery work, a cutter that has more than 450mm wire length may be required and with a similar throat size, so it has the ability to cut wide work. Modelling work may only require a short length of wire at say 150mm long.

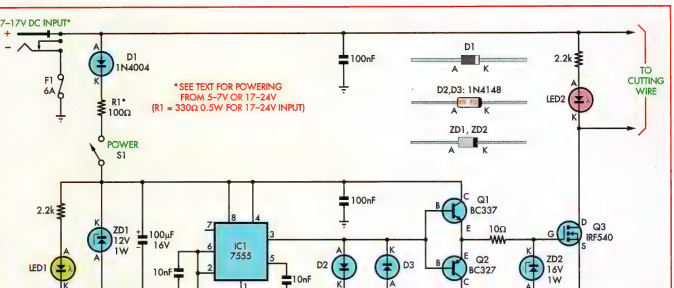
Hot Wire Cutter Controller

OK, now all that is out of the way, let's see how to make a practical Hot Wire Cutter Controller. We'll look at the actual cutter shortly.

Ours is housed in a small box containing the circuitry mounted on a single PC board. The only controls are a power switch and "temperature" knob. These are located on the top of the box. A DC socket is for the power in while power out is via leads that pass through a cable gland. These leads connect to the hot wire.

The temperature knob doesn't actually control the wire temperature as such, rather it works by controlling the rate at which power to the resistive wire is switched on and off which in turn controls the average power applied.

This average power sets a constant temperature in the wire. At full setting for the hot wire controller (fully clockwise), power is delivered continuously to the hot wire, providing the maximum power. As the control is wound anticlockwise, the percentage of time that the power is delivered to the hot wire is reduced. At the mid point adjustment setting, for example, the controller applies power to the wire for half the time and so power is 50%.



HOT WIRE CUTTER CONTROLLER

Fig. 1: the hot wire cutter controller sets the wire temperature by varying the on/off power ratio, switched by Q3.

The controller can adjust the power from essentially fully off through to fully on allowing a full range of heat adjustment for the hot wire.

The circuit

A CMOS version of a 555 timer (IC1) and a power Mosfet (Q3) plus a few extra components are used for power switching.

IC1 is arranged as an oscillator with the 10nF capacitor at pins 2 and 6 charged and discharged via the pin 3 output through diodes D2 and D3 and VR1.

With the 10nF capacitor discharged, pin 3 will be high at close to the supply voltage and the capacitor charges via diode D2 and the section of VR1 between the cathode (K) of D2 and the wiper of VR1. When the voltage reaches 2/3rds the supply voltage this is detected by the threshold input at pin 6. The pin 3 output then goes low at close to 0V. Now the 10nF capacitor discharges via diode D3 and the section of VR1 between the anode of D3 and the wiper of VR1.

The capacitor continues to discharge until its voltage reaches 1/3rd the supply. This voltage is detected by the trigger input at pin 2. The pin 3 output then goes high and the charging of the capacitor restarts.

If potentiometer VR1 is set to midway, there is a similar resistance between the wiper and the cathode of D2 and the wiper and the anode of D3. The capacitor charges and discharges over a similar time and so pin 3 is high for about the same time it is low providing a 50% duty cycle. When VR1 is set so the wiper is fully toward the cathode of D3, the 10nF capacitor charges very quickly, directly via D2 and so the pin 3 output is only high for a brief period. The period during which the pin 3 output is low is much longer due to discharge via the full VR1 resistance.

In a similar way when the wiper of VR1 is set fully toward the anode of D3, pin 3 is low for a short period as it discharges the capacitor directly via D3. Charging is via D2 and the full VR1 resistance.

Frequency of operation remains the same regardless of the position for VR1 since the frequency is the inverse of the total period for when pin 3 is both low and high. The total resistance of VR1 and the 10nF capacitor sets this period, which is about 69µs (0.693 x 10nF x 10kΩ) and frequency is the inverse of this, about 14kHz.

The output (pin 3) drives buffer transistors Q1 and Q2. When pin 3 is high, Q1 is switched on to drive the gate of Mosfet Q3 via the 10# resistor. When pin 3 goes low, Q2 switches on to discharge the gate of Q3 via the 10Ω resistor. The 16V zener diode ZD2 prevents the gate going beyond the safe operating voltage for the Mosfet device.

Mosfet Q3 drives the resistance wire between the plus supply and the drain.

Indicator LED2 lights when Q3 is on and its brightness is depends on the duty cycle of the switching. Full brightness is when the Mosfet is continuously switched on.

The power indicator LED1 lights to show when power to the circuit is connected via switch S1. Diode D1 provides reverse polarity protection while the R1 resistor limits current to the oscillator circuit, regulated to 12V by zener diode, ZD1. This conducts when the input supply is above 12.6V. The zener is required to prevent IC1 being powered by more than its absolute maximum voltage of 15V for the LMC555CN.

The circuit as shown is designed for a supply between 7V and 17V but it can be used with lower voltages down to 5V and up to 24V with some minor changes. We do not recommend controlling over 5A.

Other voltage operation

If you plan to operate the controller with a supply that is between 17V and 24V, then R1 should be changed from 100Ω to 330Ω 1/2W to reduce the

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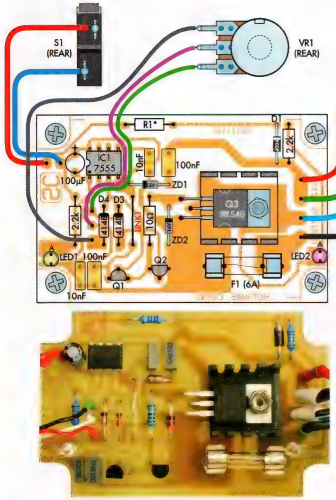


Fig.2: same-size component layout, with a matching photo below.

power dissipation in the 12V zener diode. No other changes are necessary.

Normally we wouldn't recommend operating with voltages lower than 7V but there might be situations where this is necessary. To do so, changes are necessary so that the gate drive to Mosfet Q3 is sufficient for the device to switch on fully. To allow this Q3 is changed to a logic level type, the IRL540N Logic level Mosfet. (The IRL540N is available from Futurlec, www.futurlec.com).

Also, replace D1 with a wire link and change Zener diodes ZD1 and ZD2 to 9V 1W types. Note that reverse polarity protection without Diode D1 relies on ZD1 conducting with reverse supply. R1 remains at 100Ω as shown and current is limited to 64mA or less through the 100Ω resistor. This resistor should be 1/2W rated.

Construction

The Hot Wire Cutter Controller is constructed on a PC board coded 18112101, measuring 63.5 x 85mm.

The PC board is mounted so that the plastic case is actually upside-down – ie, the base of the case becomes the front panel and the lid is on the bottom. This means that the switch S1 and the potentiometer VR1 are mounted through the base of the case.

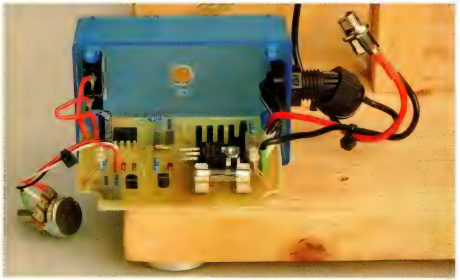
The PC board mounts with the components facing the base of the case. The board is shaped so the corner pillars are cleared and so the PC board sits on the internal side supports in the box. When the lid is in position, the PC board is held tightly in place.

Begin construction by making sure the board fits into the case and then checking the PC board for breaks in tracks or shorts between tracks and pads. Repair if necessary. Check the sizes of the holes are correct for each component to fit in position. The screw terminal holes are 1.25mm in diameter compared to the 0.9mm holes for the ICs, resistors and diodes. Larger holes again are used for the fuse clips.

Assembly can begin by inserting the resistors and wire link. When inserting the resistors, use the resistor colour code table and/or a digital multimeter to confirm each resistor value. The diodes can now be installed - these are all polarised, so must be mounted with the orientation as shown. Note that there are three different diode packages: take care!

Mosfet transistor Q3 mounts horizontally on its heatsink and both the transistor and heatsink are held in place with a 6mm M3 screw and nut. Bend the leads at right angles to suit the holes in the PC board and secure it to the heatsink and board with the screw and nut before soldering the leads in place.

PC stakes can be installed for the three terminals used for wiring to VR1 and for the power switch S1 and the DC socket and hot wire connections.



Here's how it all looks just before the pot and DC socket are screwed into position and the board is pushed back into the case, ready for mounting.

The completed PC board "folds" down into the bottom of the case so that the case lid becomes the new base. Only two screws hold the lid on; the other two holes are used to secure the Controller to the Hot Wire Cutter baseboard.

IC1 can be mounted on a DIP-8 socket or directly onto the PC board. Make sure the socket and IC are installed with the correct orientation. Orientation is with the notch positioned as shown.

Transistors Q1, the BC337 and Q2, the BC327, can now be soldered in place.

If a clear or translucent box is used, the LEDs are mounted inside the box with their tops about 20mm above the PC board surface. If a non-see-through box is used, the LEDs must be mounted high enough – the top of the LED about 25mm above the PC board – for them to peek through the base of the box (which becomes the front panel). Take care with the LED orientation. The anode has the longer lead.

Capacitors can be mounted next, again ensuring the electrolytic types are oriented correctly.

Fuse clips for the fuse F1 can be installed noting that each clip has an end stop to prevent the fuse sliding out. These end stops are oriented to be at the outside of the fuse. Usually it is easier to clip the fuse in the fuse clips first and then place the clips into the PC board. That way they will be oriented correctly.

Finishing off

The front panel label can be used as a guide to the hole positions for the switch and the potentiometer. The DC socket is located on the side of the case roughly above where IC1 is positioned.

Note that the DC socket could be a 2-pin DIN socket instead to suit the 4A current when Cuprothal is used as the resistance wire. Additionally, the plug connector for the supply would need to be changed to a DIN right angle plug.

At the outlet end of the box is placed the cable gland for the hot wire cutter connections.

When soldering the wires from the switch and potentiometer to the PC board, use heatshrink tubing over all connections except the switch terminals. Wires connecting to the switch terminals need to be soldered to the side of each terminal with the lead exiting from the terminal side. This is because the switch sits almost on top of the PC board, when assembled in the box.

We secured the lid onto the case with only two screws placed at diagonal corners. The other two lid screw positions are used to secure the upside-down case (with lid) to the baseplate of the Hot Wire Cutter using M3 x 30mm screws inserted from the underside of the baseplate. The lid can be used as a template for the hole positions for drilling into the baseplate.

Note that when using M3 screws, the corner pillars of the box need to be tapped for an M3 thread. This can be done (preferably) using an M3 tap, or if you don't have one, using an M3 screw that has a filed notch along one side of the thread to provide a thread cutting edge. The remaining two corner pillars can be left untapped so the supplied securing screws can be used.

Parts list – Hot Wire Cutter Controller

1 UB5 box 83 x 54 x 31mm, translucent blue or clear (or black/grey – see text)
1 front panel label 78 x 50mm
1 PC board coded 18112101, measuring 63.5 x 85mm
1 2.5mm DC bulkhead socket (or 1 2-pin DIN plug and 2-pin DIN socket – recommended for 4A use)
1 SPST mini rocker switch (S1)
1 knob to suit VR1
1 mini TO-220 heatsink 19 x 19 x 9.5mm
2 M205 PC board fuse clips
1 6A M205 fuse
1 cable gland for 3-6.5mm cable
1 10mm M3 screw & nut (for Q3 and the heatsink)
9 PC stakes
1 100mm length of light gauge red hookup wire
1 50mm length of light gauge green hookup wire
1 50mm length of light gauge white hookup wire
1 100mm length of 24 x 0.2mm figure-8 wire

Semiconductors
1 ICM7555IPA or LMC555CN CMOS timer (IC1)
1 IRF540 100V 32A N-channel Mosfet (Q3)
1 BC337 NPN transistor (Q1)
1 BC327 PNP transistor (Q2)
1 12V 1W zener diode 1N4742 (ZD1)
1 16V 1W zener diode 1N4745 (ZD2)
1 1N4004 1A diode (D1)
2 1N4148 switching diodes (D2, D3)
2 3mm LEDs (LED1 – red, LED2 – green)

Capacitors
1 100µF 16V PC electrolytic
2 100nF MKT polyester (code 104, 100n or 0.1)
2 10nF MKT polyester (code 103, 10n or 0.01)

Resistors (0.25W 1%)
2 2.2kΩ (4-band code red red red brown)
1 100Ω (4-band code brown black brown brown)
1 10Ω (4-band code brown black black brown)
1 10kΩ 16mm potentiometer (VR1)

Building the Hot Wire Cutter

Perhaps the best description of our Hot Wire Cutter is of a miniature gallows, albeit without the hangman's noose.

As they say, a picture (and a diagram!) are worth a thousand words, so we'll save a few thousand by referring to the picture and diagram of our prototype cutter. They are pretty-much self explanatory.

For this particular size cutter a 9V 3A plugpack is suitable. You may care to change the dimensions if required, bearing in mind the comments about wire length and power requirements.

Ours uses a 240mm length of 0.315mm Nichrome 80 wire. With this length the cutter can cut up to about a 230mm height of material; much thicker than you would normally expect to cut. Additionally it can cut material in up to 240mm wide sections.

The cutter is made from dressed radiata pine. A flat 19mm-thick baseplate, 500 x 240mm, supports two uprights (280 x 19 x 12mm) that in turn support a 370 x 19 x 12mm lever arm. This arm is pivoted at the top of the upright, while an extension spring provides the tension for the wire at the opposite end of the arm.

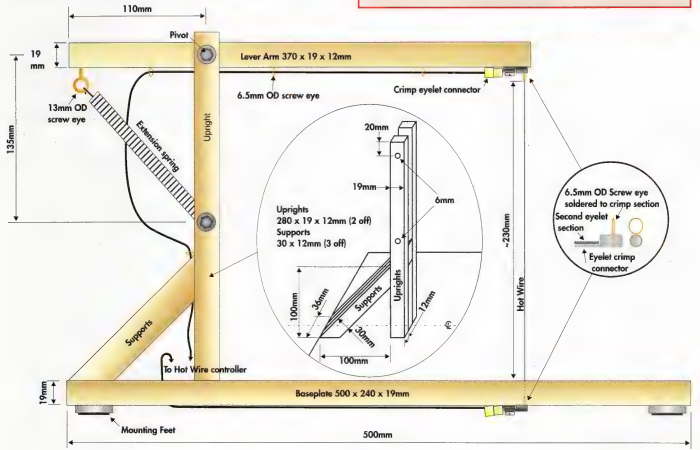
The baseplate sits on four mounting feet to allow room for the wiring and for the connectors to the lower hot wire attachment.

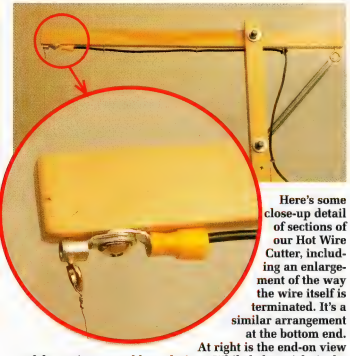
The lever arm pivots on a 6mm x 50mm bolt passing through the uprights, with 6mm washers between the lever arm and the uprights. The nut is not tightened up fully, so

Parts list – Hot Wire Cutter
with a 240mm wire length

- 1 1m length of 19 x 12mm DAR (dressed all round) pine
- 1 500mm length of 30 x 12mm DAR pine
- 1 240 x 19 x 500mm pine or MDF board
- 1 extension spring, 9.525mm diameter x 95.26mm length x 1.041mm (eg, Century Spring Corporation C-215, available from Bunnings Hardware)
- 4 screw-on equipment mounting feet 30mm diameter (eg Jaycar HP-0830)
- 4 wood screws to suit equipment feet mounting
- 1 brass plated screw eye 3mm gauge 30mm long (13mm OD eyelet)
- 6 brass plated screw eyes 1.6mm gauge 15mm length (6.5mm OD eyelet)
- 2 50mm M6 galvanised screws, with nuts
- 6 M6 washers
- 2 30mm M3 screws to secure the controller box to baseplate
- 6 crimp eyelets with 5.3mm ID hole and 6.6mm cable entry
- 2 8G x 12mm round head screws for timber
- 2 6G x 25mm countersunk head screws for timber
- 1 1m length of 24 x 0.2mm Fig-8 wire

Resistance wire – see controller text





Here's some close-up detail of sections of our Hot Wire Cutter, including an enlargement of the way the wire itself is terminated. It's a similar arrangement at the bottom end. At right is the end-on view of the spring assembly and pivot. While below right is the back of the baseboard, showing the Controller connecting wire and the four non-slip mounting feet.

that the arm has free movement (we didn't use one but a locknut might be in order here).

One end of the tension spring attaches to the end of the lever arm with a screw hook while the opposite end connects between the two uprights via another 6mm x 50mm bolt.

Connectors

Connectors for the hot wire itself are made using crimp eyelets and a 1.6mm gauge screw eye with a 6.5mm OD. The crimp section of the crimp eyelet has a small hole drilled through it and the screw eye is inserted into this hole and is soldered in place. To add strength to the assembly, the eyelet section of a second crimp eyelet is removed from its crimp section and soldered on top of the main crimp eyelet. The resulting connector is secured to the underside of the horizontal beam using an 8g x 12mm screw. Another crimp eyelet is also secured with this screw and is for connection to the wire that leads to the Hot Wire Controller.

The wire is supported using four small screw eyes spaced along the lever arm and down the upright, as shown in the diagram.

For the lower hot wire connection, the construction is the same only that the assembly mounts beneath the baseplate that protrudes into a 10mm hole.

The hot wire wraps around the screw eyelet a couple of times and then around itself a few times to attach the wire at each terminal. The power wire leading to the hot wire controller passes under the baseplate and then through a hole to access the controller.

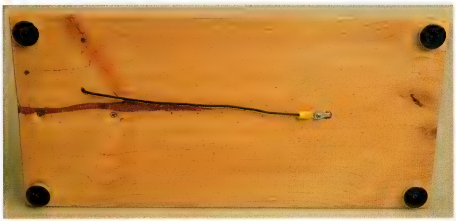
When positioning the hot wire terminal at the top horizontal beam, it should be such that the wire sits vertical when connected to the lower baseplate terminal.

Tension on the wire needs to be about 700g. This could be measured but we found the easiest way was with the "twang" test – when properly tensioned, plucking the cold wire should result in a note somewhere around middle "C" – about 260Hz (if you don't have a piano or keyboard, Wikipedia has a note you can play [http://en.wikipedia.org/wiki/C_(musical_note)].

Spring tension sets the wire tension and can be set by the positioning of the lower M6 bolt.

Spring tension will be greater than 700g. This is because the pivot point (or fulcrum) is not centred on the beam. For our design the distance between the fulcrum and the hot wire is almost 250mm and the horizontal distance between the fulcrum and the spring attachment on the beam is 105mm. As a consequence the spring is tensioned by about 700g x 250/105mm. This amounts to about 1.66kg.

Using the dimensions shown in the diagram, with a 230mm length of cutting wire (ie, fitted length) the specified 95.25mm-long spring is stretched to approximately 150mm.



Hot Wire Cutter: Resistance Wire and Power Requirements

The type of wire and the wire length used in a Hot Wire Cutter determines the power requirements for the supply that drives it.

For 100W per meter, a 500mm length of wire requires up to 50W of power while a 150mm wire length only requires 15W of power.

How this translates into voltage and current is dependent on the actual wire used for the wire cutter. We know that the power is voltage multiplied by the current but the value of current is dependent upon the wire resistance.

Several types of resistance wire could be used but the two types of wire we recommend are Cuprothal 49 and Nichrome 80. Both are about 0.315mm in diameter, which provides a fine cutting edge for accurate cuts.

Cuprothal 49 has a melting point of 1280°C and maximum continuous operation at 600°C. It is an alloy that comprises 44% Nickel with 55-56% Copper. Other metals in the alloy include about 1% Magnesium and 0.5% iron. Cuprothal 49 is corrosion resistant and is used for precision resistors due to its very low change in resistance with temperature. The '49' designation refers to the resistance of 0.49Ωmm^2/m value

Nichrome 80 has a melting point of 1400°C and maximum continuous operating temperature at 1200°C. Nichrome 80 is an alloy of 80% nickel and 20% chromium. It is also resistant to corrosion and is generally used for heating elements such as toasters and hair-dryers. The '80' value refers to the proportion of Nickel in the alloy.

Melting points for Cuprothal 49 and Nichrome 80 are well above the melting points for Polystyrene and Polyurethane.

More information on these alloys can be found at www.kanthal.com/products/materials-in-wire-and-strip-form/wire/resistance-heating-wire-and-resistance-wire/. Note that the Nichrome 80 manufactured by this company is called Nikrothal 80.

Resistance wire sources

Dick Smith Electronics (www.dse.com.au) sell both Cuprothal and Nichrome wire. They are 28B&S/AWG (about 0.32mm in diameter) and are 4m in length. The catalog number is W3200 for the Cuprothal and W3205 for the Nichrome wire. Wire resistance for the W3200 is 6.08Ω/m and for the W3205, 13.4Ω/m.

Jaycar Electronics (www.jaycar.com.au) sell the Nichrome wire with catalog number WW-4040. It is 28B&S at 0.315mm in diameter and 4m long with a resistance of 13.77Ω/m. Jaycar do not stock Cuprothal wire.

Why the Dick Smith Electronics Nichrome wire has a slightly lower resistance per meter compared to the Jaycar Nichrome wire is possibly due to a slightly larger wire thickness or slightly different alloy composition. The different resistance values do not affect the current and voltage requirements to drive the wire to any noticeable degree.

For our calculations we used 6.08Ω/m for the Cuprothal wire and 11.4Ω/m for the Nichrome wire.

For Cuprothal we calculate the required current and voltage noting that the power requirement is 100W/m and that power is the voltage squared divided by the resistance.

The required voltage is therefore the square root of the power multiplied by the resistance. A similar formula for power is the current squared multiplied by the resistance. In this case the current is the square root of the power divided by the resistance.

These calculate to a current requirement of about 4.05A and 24.6V for a 1m length of wire. For shorter lengths of wire, the current requirement remains at 4.05A while the voltage is reduced proportionately. For example, a 500mm length of wire requires 12.3V at 4.05A.

For the DSE Nichrome wire at 13.4Ω/m calculations set the current at 2.73A and 36.6V/m. For the Jaycar Nichrome wire at 13.77Ω/m this equates to a current of 2.69A and 37.1V/m.

For different wire use these formulas to find the required voltage and current for a 1m length of the wire.

$$V = \sqrt{\text{(power requirement per metre x wire length in metres}^2\text{ x the wire resistance in }\Omega\text{/m)}}$$

$$I = \sqrt{\frac{\text{power requirement per metre}}{\text{the wire resistance in }\Omega\text{/m)}}}$$

Note that the power requirement per metre is 100W.

Also note again that the current (I) does not change with length because the resistance changes at the same rate as the power requirement. So for example a 500mm wire length requires half the power compared to 1m and so is 50W. The resistance is also halved compared to the 1m length.

Using different wire

We do not recommend using other wire for the wire cutter. Cuprothal and Nichrome wire are resistant to corrosion – this is something to take into account because when the wire is heated, corrosion is accelerated. Corrosion in this application is the formation of oxides of the wire alloy by reaction with oxygen in the air.

Having said that, some readers may wish to use resistance wire that they may on hand or pearhaps is possibly easier to obtain.

For example, one possible alternative is stainless steel wire such as that used in boating and fishing equipment.

A typical stainless steel wire has a resistance of 0.9Ωmm^2/m, although this is dependent upon the grade. A 0.315mm diameter length of the wire has an area of 0.0779mm^2 and so 1m of wire will have a resistance of 11.54Ω. This resistance is calculated by dividing the wire area into the Ωmm^2/m value. Current requirements for this wire would be 2.9A at 34V.

Using a shorter length of this wire will set the required voltage to a lower value. A thicker gauge wire will increase the current requirement but lower the voltage requirement. It would be wise to measure the wire resistance to ensure it is suitable for a hot wire cutter application before purchasing.

Other wire may not have a suitable resistance. When the wire resistance is too high the voltage needs to be excessively high..Alternatively, when the wire resistance is too low, the current will be excessively high.

For example, steel piano wire typically has a resistance of 0.118Ωmm^2/m so 0.315mm wire will have a resistance of 1.51Ω/m. The wire would require just over 8A for a 1m length at a voltage of just over 12V. This is a high current and is not suited for our Hot Wire Cutter Controller. Additionally, the steel wire is liable to corrode at the elevated temperatures of a wire cutter.

A similar result is for a steel guitar string. We measured a light gauge E4 steel string for an acoustic guitar at 1.5Ω for a 660mm length. This is 2.27Ω/m. Its diameter was around 0.3mm.

Table 1 shows a list of standard switchmode power supplies suitable for driving the shown Cuprothal and Nichrome wire lengths. These power supplies are either in plugpack form or as in-line power units. Alternative supplies include bench power supplies of a suitable current and voltage rating and batteries.

For example, a 12V lead acid battery could be used as a 12V

supply for the 487mm and 328mm wire lengths shown in the table.

The wire length does not need to be as precise as shown. A 519mm wire length as expressed in the table could be plus or minus 5% or about 25mm longer or shorter without changing the cutting effectiveness of the wire cutter.

Wire length	Current @ full supply voltage	Standard switchmode power supply rating	Wire type
Wire size: 28B&S (or AWG) or 0.315mm in diameter			
973mm*	4.05A@24V	24V 5A	Cuprothal
811mm*	4.05A@20V	20V 5A	Cuprothal
656mm*	2.73A@24V	24V 3A	Nichrome
770mm*	4.05A@19V	19V 5A	Cuprothal
519mm*	2.73A@19V	19V 3.2A	Nichrome
487mm	4.05A@12V	12V 5A	Cuprothal
410mm	2.73A@15V	15V 3A	Nichrome
365mm	4.05A@9V	9V 5A	Cuprothal
328mm	2.73A@12V	12V 3A	Nichrome
304mm	4.05A@7.5V	7.5V 5A	Cuprothal
246mm	2.73A@9V	9V 3A	Nichrome
205mm	2.73A@7.5V	7.5V 3A	Nichrome
164mm*	2.73A@6V	6V 3A	Nichrome
203mm*	4.05A@5V	5V 5A	Cuprothal
137mm*	2.73A@5V	5V 3A	Nichrome

**See note in text concerning use of the Hot Wire Cutter Controller below 7V and above 17V.*

Table 1: standard switchmode supplies suitable for driving the indicated wire lengths and type for 100W/m. This power rating is suited for cutting Polystyrene and Polyurethane. A 24V lead acid battery can be used for the 973mm and 656mm lengths. Similarly a 12V lead acid battery can be used with the 487mm and 328mm lengths.

Below is a list of the switchmode supplies listed in Table 1 from Altronics (www.altronics.com.au) and Jaycar (www.jaycar.com.au).

24V	5A	Altronics	M 8973	
24V	4.2A	Altronics	M 8996	
20V	5A	Altronics	M 8996	
19V	5A	Altronics	M 8996	
19V	3.2A	Jaycar	MP-3246	
18V	5A	Altronics	M 8996	
12V	5.4A	Altronics	M 8939	
12V	5A	Jaycar	GH-1379	*Multi-voltage/ current outputs
12V	5A	Jaycar	MP-3242	
12V	3A	Altronics	M 8987A*	
9V	3A	Altronics	M 8987A*	
9V	3A	Jaycar	MP-3496	
7.5V	3A	Altronics	M 8987A*	
6V	3A	Altronics	M 8987A*	
5V	3A	Jaycar	MP-3480	
5V	3A	Altronics	M 8987A*	
5V	3A	Altronics	M 8909A	

Cutting other plastic types

While the 100W/m power into the wire is suitable for Polystyrene and Polyurethane, the cut tends to be slow with other plastics such as PET, ABS and Acrylic (or Perspex). For these, power requirement could be set higher for a faster cut. With power set at 180W/m, this has the wire glowing red hot. We recommend using Nichrome 80 wire due to its high continuous operating temperature. We do not recommend using Cuprothal at 180W/m.

At the 180W/m power setting, you can cut a PET bottle in half and cut long plastic IC carriers into separate sections suited for packaging individual ICs. When cutting ABS, Acrylic or Perspex, the edges will generally be a little rough and if clean edges are needed may require finishing with abrasive paper or a file.

Cutting rate is about 1mm per second at full power.

We also tested the wire cutter for cutting Nylon, such as used for PC board standoffs and for screws. This proved unsuccessful since the cut resealed itself as the wire passed through the material.

Wire Length	Current @ full supply voltage	Standard switchmode power supply rating	Wire Type
Wire size: 28B&S (or AWG) or 0.315mm in diameter			
489mm*	3,67A@24V	24V 5A	Nichrome
408mm*	3.67A@20V	20V 5A	Nichrome
387mm*	3.67A@19V	19V 5A	Nichrome
244mm	3.67A@12V	12V 5A	Nichrome
183mm	3.67A@9V	9V 5A	Nichrome
152mm	3.67A@7.5V	7.5V 5A	Nichrome
102mm*	3.67A@5V	5V 5A	Nichrome

**See note in text concerning use of the Hot Wire Cutter Controller below 7V and above 17V.*

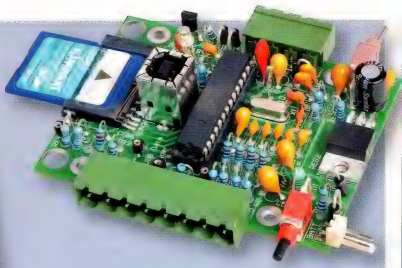
Table 2: suitable switchmode supplies to drive the hot wire at 180W/m for a given length. A 24V and 12V lead acid battery could be used for the 489mm and 244mm wire lengths respectively.

Other power supplies?

As we mentioned earlier, a 12V (or perhaps two 12V) lead-acid batteries could be used for the power supply in many instances. But if you have an old computer power supply, it might be possible to press that into service. Almost invariably, they have two individual outputs, 5V and 12V, (definitely ***not*** linkable for 17V!) and are usually rated at a minimum of 150W (~12A); some are much higher. Of course, the bulk of a computer supply is a consideration.

An alternative, much smaller, supply you might like to consider is one intended for a computer external hard disk drive or indeed a laptop. Generally these are rated at between 12V and 19V or so with currents from 2-5A and due to the huge numbers made, are often very low in cost.

Just beware, however, that some are not all that marvellous when it comes to quality control (or maybe even quality!): not long ago we purchased a couple of 12V external HDD supplies via the internet and one of them, in the words of that old Hillaire Belloc poem, "exploded with a loud report" the moment it was plugged into the mains. (OK, so together they only cost us $7.50 including postage from China . . . what did we expect?) SC



Based on a PIC micro, this simple project can log lots of data to a memory card. It can read from many types of digital and analog sensors and features a real-time clock and calendar to "time-stamp" the data. It has a USB port and comes with a PC host program, allowing you to configure the sensors, change settings and charge the battery.

Universal USB Data Logger: Pt.1

By MAURO GRASSI

THIS LOW-POWER USB Data Logger is useful for a myriad of applications, especially where you need to log data over a long time period. It logs to an MMC/SD/SDHC memory card (with FAT file system), which means you can store up to 32GB of information. That's a lot of logged data.

The average current consumption is typically less than 1mA and it can be powered using two AAA cells (either NiMH rechargeable types or alkaline). Alternatively, it can be powered from a USB port on a PC or an external 5-7V DC supply.

If NiMH cells are fitted, these will be recharged whenever the device is connected to a PC (via the USB port) or powered from an external DC supply.

The logger can accept inputs on up to eight lines, with a maximum of up to six digital lines and up to four analog lines. Many different types of analog and digital sensors can be used and the digital inputs can also be used for frequency measurement or event counting. It is even possible

to connect a GPS (Global Positioning System) module to log geographical coordinates as well.

For storage, just about any MMC, SD or SDHC memory card can be used. They are ideal for this application because they are cheap, reliable, have low power requirements and are available in capacities ranging from 16MB up to 32GB.

Typical applications

A typical application for this device would be to log data from a remote weather station. For example, let's say you wish to monitor a weather station with humidity, wind speed, rainfall, temperature and barometric pressure sensors. With this device, you can log their values over many days into a CSV (comma separated values) file on the memory card. Then, when you've finished logging, you can connect the USB Data Logger to your Windows-based PC and download the file via the USB port.

Alternatively, you could simply remove the memory card and use a memory card reader. The downloaded log file can then be opened using Open Office or Microsoft Excel. From there, it's easy to graph the readings and analyse them.

Another use involves diagnosing a problem with a car engine. You can monitor the relevant engine sensors and log them while driving, then later analyse the data to locate the problem. You can even log your route if you connect a GPS module to the USB Data Logger.

These are just two examples and there are lots of other uses, including monitoring industrial processes, collecting all sorts of field data, trouble-shooting and testing. We've made the logger as flexible as possible by making it compatible with a wide range of sensors.

PIC microcontroller

The USB Data Logger is built around a PIC18F27J53-I/SP microcontroller (IC1). This is an 8-bit microcontroller with 128KB program (Flash) memory and 3KB of SRAM (Static Random Access Memory). It's a 28-pin device and is well suited to this application due to its impressive list of internal peripherals and low price.

The following peripherals are used in this project: the USB device controller; the integrated RTCC (Real Time Clock Calendar) with separate oscillator circuit; the SPI, I²C and UART serial peripherals; ten output compare/capture peripherals; one of three comparators; the 12-bit A/D (Analog-to-Digital) converter with internal band gap reference; and the comparator voltage reference.

SPI (Serial Peripheral Interface) is a four-wire (plus ground) serial communication protocol, while the I²C (Inter-IC Communications) and UART (Universal Asynchronous Receiver/Transmitter) peripherals use two wires.

Other microcontroller features which this project benefits from include the DMA (Direct Memory Access) support for the SPI peripheral, the low-power "sleep" modes and the very useful PPS (Peripheral Pin Select) feature.

Sensor support

The USB Data Logger supports a wide range of sensors and these are connected via terminal block CON4. There are four digital pins (D0-D3), two analog pins (A2-A3) and two analog/digital pins (D4/A0 and D5/A1). These latter pins can be used for either digital or analog sensors (but not both). Table 1 shows the pin configurations – be sure to check the comments.

Digital sensors

The USB Data Logger is extremely versatile in that it can accept inputs from I²C, One Wire Dallas and serial port (UART) digital sensors. Using digital sensors can reduce A/D conversion errors compared to sensors connected to the analog inputs (see below). This is because digital sensors usually contain their own A/D converters which are optimised for the task.

I²C and One Wire Dallas sensors must be connected to digital inputs/outputs D0-D3 (pins 1-4 of CON4). The great thing about using I²C sensors is that you can connect many different sensors to the same I²C bus, which consists of just two lines. In fact, as many as 127 I²C devices can be connected to the same bus!

Similarly, only one line is required to connect many different One Wire Dallas sensors to the Data Logger. As the name suggests, One Wire Dallas sensors only require the use of one pin.

IC1's Peripheral Pin Select feature allows the appropriate internal com-

USB Data Logger: Main Features

- Uses an MMC/SD/SDHC memory card (FAT file system) for up to 32GB of storage capacity.
- USB full speed (12Mbps) interface for connection to a PC.
- Host PC program for Windows-based PCs.
- Up to six digital sensor inputs with support for I²C (Inter-IC Communications) and One Wire Dallas protocols. Also supports a Full Duplex Serial Port UART (Universal Asynchronous Receiver Transmitter) interface (eg, for connecting a GPS module).
- Up to four analog inputs (two shared with digital inputs) with 12-bit A/D conversion and ±5% accuracy. The analog inputs can also accept frequency signals up to 192kHz or can function as a 32-bit event counter.
- Custom scripting language allows a wide range of different digital sensors to be used.
- Low power consumption (around 1.5mA in standby mode).
- Flexible power options – can be battery-powered (using two AAA cells), USB powered or powered from an external 5-7V DC power source.
- NiMH cells can be trickle-charged using USB power or an external power source.
- An external voltage reference can be connected for greater than ±5% accuracy on the analog inputs.
- Battery protection to prevent over-discharge.
- Includes an on-board Real Time Clock Calendar (RTCC).

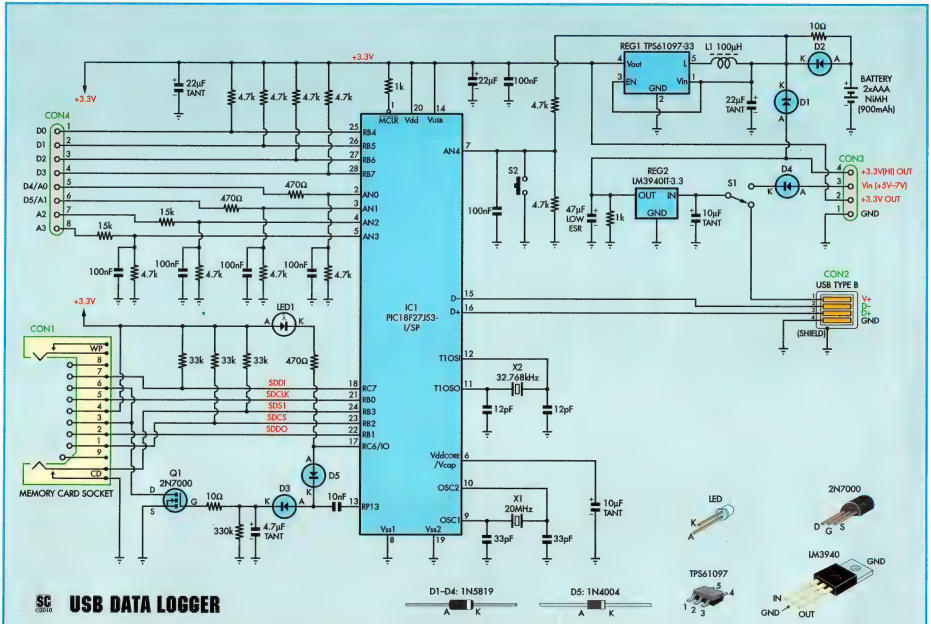


Fig.1: the circuit is based on a PIC18F27J53-I/SP microcontroller (IC1). This accepts digital and analog inputs via CON4 and reads and writes data to a memory card via CON1. IC1 also interfaces to USB socket CON2 via an internal controller, while regulators REG1 & REG2 provide 3.3V supply rails. Power can come from two AAA cells, from a USB port on a PC or from an external 5-7V DC supply.

munications peripheral to be routed to whichever sensor lines the digital sensor(s) are connected to. The supplied Windows-based host program allows you to configure the firmware for the types of sensors connected to the various inputs.

Finally, there is support for a configurable, full-duplex serial port (via the UART peripheral). Among other things, this allows a GPS module (eg, the EM-408 – Altronics K-1131) to be connected to two of the digital inputs (for bidirectional signalling). Doing this will allow position information to be logged, as well as keeping the real-time clock synchronised with GPS time, guaranteeing accurate timekeeping (more on this next month).

Analog sensors

The simplest analog sensors output a voltage that's directly proportional to the measurement value. For example, a ratiometric temperature sensor outputs a voltage that varies linearly with changing temperature. Accelerometers with analog outputs also vary their outputs linearly in response to acceleration.

Up to four analog sensors with variable voltage outputs can be used with the USB Data Logger. Inputs A0 and A1 are for sensors with low-voltage outputs (0-3.6V), while A2 and A3 are for sensors with high voltage outputs (0-13.8V). These two sensor input pairs differ only in the voltage dividers used at the inputs. While low voltage sensors can be connected to A2 and A3, the measurement resolution will be poor.

Internal voltage reference

The reduced voltages from the analog sensors are fed to inputs AN0-AN3 of IC1 and are digitised using a 12-bit A/D conversion process. Normally, the accuracy of this 12-bit A/D conversion depends on the exact supply voltage to the microcontroller.

For this reason, the firmware checks the supply voltage to IC1 regularly using an internal band gap reference (1.2V ±5%) and adjusts the A/D conversion values accordingly. Note, however, that due to the tolerance of the reference voltage (ie, 1.14-1.26V), the digitised values also have a possible error of ±5% although it will typically be better than this.

If you require an accuracy of better than ±5% for the analog sensors, a precise voltage reference can be connected to one of the four analog inputs. This reference can then be used to accurately measure the other analog sensors. Just how this is done in explained in Pt.2 next month.

Frequency and counter inputs

The Universal USB Data Logger can also measure the frequency applied to any of the six digital inputs (D0-D5), at up to 192kHz. Inputs D0-D3 can handle signals ranging from 0-5V, while D4 & D5 can handle signals from 0-3.6V. The reason that inputs D0-D3 can handle higher voltages is that IC1's input transistors are 5V-tolerant on those pins.

If you require the circuit to tolerate even higher voltages, the voltage dividers at inputs D4/A0 and/or D5/A1 can be changed to suit. This is also true for the analog inputs.

As well as measuring frequency, the six digital inputs (D0-D5) can also act as simple counters, logging the number of positive or negative edge transitions that occur. In this mode, since the counters are 32 bits, the maximum number of events that can be counted is over four billion per input.

Circuit details

Refer now to Fig.1, the circuit diagram. It consists primarily of microcontroller IC1, a memory card socket (CON1), a couple of power supply ICs (REG1, REG2) and a handful of minor components.

The sensors are connected to eight I/O pins of IC1 (RB4-RB7 & ANO-AN3) via terminal block CON4.

I²C and One Wire Dallas sensors must be connected to digital inputs/outputs D0-D3 (pins 1-4 of CON4). These lines all have 4.7kΩ pull-up resistors to the +3.3V supply rail, which is required for this type of sensor as they have open collector outputs, allowing multiple devices to share the same bus.

D4/A0 and D5/A1 (pins 5 & 6 of CON4) use a voltage divider made up of 470Ω and 4.7kΩ resistors. This means that these two inputs can accept analog sensor output voltages up to 3.3/(4700/5170) = 3.6V. The low-value series resistors (470Ω) do not preclude the use of digital sensors with these pins.

By contrast, the A2 & A3 analog inputs use voltage dividers made up of 15kΩ and 4.7kΩ resistors. This gives a maximum sensor voltage range of 3.3/(4700/19,700) = 13.8V (since the voltage fed to IC1 cannot exceed 3.3V). The 100nF capacitors form RC filters with the 470Ω & 15kΩ resistors to reject noise on the analog inputs.

Memory card interface

CON1 is the memory card socket and this has an internal normally open (NO) switch that's used to detect when the memory card is inserted. A 33kΩ

Table 1: Pin Assignments For CON4

Pin Number	Pin Name	Pin Function	Pin Comments
1	D0	Frequency Input/Digital Input or Output	Digital function, 0-3.3V signal output, 0-5V signal input
2	D1	Frequency Input/Digital Input or Output	Digital function, 0-3.3V signal output, 0-5V signal input
3	D2	Frequency Input/Digital Input or Output	Digital function, 0-3.3V signal output, 0-5V signal input
4	D3	Frequency Input/Digital Input or Output	Digital function, 0-3.3V signal output, 0-5V signal input
5	D4/A0	Digital Input or Output/Analog/Frequency Input	Analog/frequency input, 0-3.6V signal; can also be used for digital functions
6	D5/A1	Digital Input or Output/Analog/Frequency Input	Analog/frequency input, 0-3.6V signal; can also be used for digital functions
7	A2	Analog Input	0-13.8V analog input
8	A3	Analog Input	0-13.8V analog input

pull-up resistor normally holds the SDS1 line high but this is pulled to ground when the card is inserted and the switch is closed.

The memory card is powered from the 3.3V rail and this is connected directly to pin 4 of the socket. This negative side of the supply is switched by Mosfet Q1 (2N7000) as its drain is connected to pins 3 & 6 (GND) of CON1.

Charge pump

This FET needs at least 4.5V applied to its gate to guarantee that it turns on fully, which is higher than the main power supply rail (3.3V). Therefore its gate is driven by a charge pump circuit based on diodes D3 & D5, a 10nF capacitor and a 4.7μF tantalum capacitor.

To power the memory card up, IC1 drives this charge pump circuit using a square wave from pin 13 (RP13), generated by one of its output compare (OC) peripherals. At the same time, D5's anode is pulled high by pin 17 of IC1 (which also controls LED1).

It works as follows. When the signal at RP13 is close to 0V, the 10nF capacitor quickly charges via D5 to about 3.3V – 0.6V = 2.7V (0.6V is the drop across D5). Then, when the signal at RP13 subsequently goes high (ie, to 3.3V), the junction of this capacitor with D5 is immediately pulled to 3.3 + 2.7 = 6V. At this point, D3 conducts, charging the 4.7μF tantalum capacitor.

The charge on the tantalum capacitor builds over several cycles until D3 no longer conducts, at which point its charge is close to 6V. So the circuit "doubles" the applied voltage (or near enough).

The 6V is high enough to turn on Mosfet Q1 via the 10Ω current-limiting resistor. The associated 330kΩ pull-down resistor ensure that Q1 turns off when there is no longer any drive signal to the charge pump circuit from the microcontroller.

During periods of extended idle time (ie, when not logging for extended periods), the microcontroller goes to sleep and its pin 13 output goes low. As a result, Q1 is off and this turns off the supply to the memory card, to conserve power.

From this, it follows that the higher the logging frequency, the greater the power use and this needs to be considered if the unit is powered solely from a battery. In addition, if the logging interval is very short (ie, less than 5s), power to the memory card will not be turned off. That's because the initialisation sequence for the memory card would take too long and logging events would be missed while initialisation was taking place.

Table 2: Supply Connections For CON3

Pin Number	Pin Name	Pin Function & Comments
1	GND	Ground (0V)
2	+3.3V	+3.3V rail from REG1; capable of supplying up to 50mA. Can be used to power low-current external sensors. Always powered.
3	Vin	Input for external 5V - 7V DC power supply
4	Vdd (HI)	+3.3V rail from REG2. Can supply up to about 250mA provided either USB power or external power is applied. Used to supply "power hungry" sensors.

Double function

As well as driving D5 for the charge pump, IC1's RC6 (pin 17) output also controls LED1. This flashes briefly whenever logging is turned on or off and also occasionally flashes while ever logging is enabled.

This LED can also be driven while the charge pump is in operation; in other words, the RC6 pin of IC1 is multiplexed. This doesn't interfere with the charge pump operation, since the firmware automatically adjusts the drive to LED1 and the RP13 output as appropriate.

Memory card SPI connection

The SPI (Serial Peripheral Interface) peripheral of IC1 handles communications with the memory card, while high-level software layers add support for a FAT (File Allocation Table) file system. This file system (including both FAT and FAT32) is supported by all common operating systems.

MMC/SD/SDHC cards can be accessed either in their native mode or in SPI mode. The advantage of SPI mode is that the interface is simpler and this makes the hardware layer easy to implement. The penalty is slower transfer speeds but this is of no consequence here as SPI speeds are quite adequate for data logging.

IC1 communicates with the memory card using one of the two on-board SPI peripherals, in this case SPI2. It also has hardware support for DMA (Direct

Memory Access) for this peripheral, allowing data to be transferred to and from the memory card at the same time as the microcontroller is executing code, making data transfer more efficient.

SPI communication uses a 4-line bus and is capable of full duplex transfers between a host and a slave. The four lines are: SDCS (chip select – active low), SDDO (serial data output), SDDI (serial data input) and SDCLK (serial clock).

In this case, the microcontroller is the SPI master. When the SDCS line is pulled low, the memory card becomes active and listens for commands.

The SPI peripheral is routed via the PPS (Peripheral Pin Select) feature of IC1, so that the SDCLK line is at pin 21 and the SDDI and SDDO lines are at pins 18 & 22 respectively. The latter two are connected (transposed) to the DO (Data Out) and DI (Data In) lines respectively of the memory card. These lines are used to transmit and receive data in conjunction with the clock signal (SDCLK) generated by IC1.

The SPI bus runs at 12MHz in this application, which is the fastest that the microcontroller will allow. Note that the SDCS line is pulled high by a 33kΩ resistor to disable the memory card by default (eg, when the microcontroller is in sleep mode), while the data output line from the memory card is also pulled high by a 33kΩ resistor.

Two oscillators

The microcontroller uses two oscillators – primary and secondary. The primary oscillator uses a 20MHz crystal (X1) to provide the main system clock. The oscillator's output is divided by five and multiplied by 12 (using an internal PLL stage) to derive the 48MHz clock which is used by the USB peripheral (USB full speed device, 12Mbps) and the core.

The core runs at 12 MIPS (Million Instructions per Second), which is its highest rated speed.

The firmware implements a full-speed (12Mbps) USB device and the D+ & D– data outputs (pins 16 & 15) connect to a USB Type-B socket (CON2). This can be connected to a PC using a standard USB cable. A USB driver is required and we describe how this is installed in Pt.2. (Note: the USB Data Logger has its own VID (Vendor ID) and PID (Product ID) pair, sub-licensed by Microchip).

The PC board fits neatly into a plastic instrument case that's available from Altronics. The full assembly details will be in Pt.2 next month.

The secondary oscillator uses a 32.768kHz watch crystal (X2) and two 12pF ceramic loading capacitors. This oscillator is almost always powered (even when the microcontroller is sleeping) and is used for timekeeping by the real-time clock/calendar (RTCC) peripheral inside IC1. This operates without firmware intervention to provide accurate timekeeping.

There are no switches to set the time and date. Instead, the time and date are automatically synchronised with the PC when the logger is connected to a USB port and the host program is launched.

Battery protection

The secondary oscillator is only switched off when the USB Data Logger goes into "deep sleep" mode. This happens only if the firmware detects that the battery is critically low. In that case, IC1's core is shut down and goes into a deep sleep mode to prevent the cells from discharging any further (which could damage them).

In addition, in this special sleep mode, the contents of the SRAM are lost and the timekeeping fails (to prevent battery drain).

Once it has entered deep-sleep mode, the USB Data Logger will require a reset to resume normal operation. The way to do this is explained in next month's article.

Note that, during normal operation, the microcontroller spends most of its time sleeping (thus reducing the power consumption) until the next logging event occurs. This sleep mode is different from the deep-sleep mode described above, however. While sleeping, the RTCC still operates, to maintain accurate timekeeping.

Sensing the supply voltage

During operation, IC1 monitors the supply voltage applied to boost regulator REG1. This is done by also applying this voltage to an ADC input, in this case AN4 at pin 7. As shown on Fig.1, the supply voltage is fed to AN4 of IC1 via a voltage divider consisting of two 4.7kΩ resistors. IC1 then converts the divided analog voltage on its AN4 input to a 12-bit number.

When the logger is powered using two AAA cells, the supply voltage to REG1 will be about 2.7V at most (the maximum cell voltage is around 1.4V per cell and there is a Schottky diode in series with the positive battery terminal). On the other hand, if external power is applied to REG2, the voltage applied to REG1 will be close to 3V (the output of REG2 is at 3.3V and Schottky diode D1 is in series with its output).

A 100nF monolithic capacitor bypasses the divided voltage applied to AN4. This will be 1.35V maximum for a battery and about 1.5V if external power is applied.

Parts List For USB Data Logger

1 PC board, code 04112101, 60 x 78mm
1 plastic instrument case (Altronics H-0342 or H-0343)
1 SPDT sub-mini toggle switch (S1) (Altronics S-1421)
1 sub-mini momentary pushbutton switch (S2) (Altronics S-1498)
1 28-pin 0.3-inch IC socket (or 2 x 14-pin IC sockets)
1 20MHz crystal (X1)
1 32.768kHz crystal (X2) (Altronics V-1902)
1 USB Type-B socket, vertical PC-mount (Tyco Electronics Amphenol 5787834-1)
1 2 AAA battery holder (Jaycar PH-9226)
2 AAA 900mAh NiMH cells (Jaycar PH-9226) or 1 x 2-pack AAA 950mAh NiMH cells (Altronics: S-4742C)
1 8-way horizontal PC-mount 5.08mm pluggable terminal block header (Altronics P-2598, Jaycar HM-3108)
1 8-way screw terminal socket (Altronics P-2518, Jaycar HM-3128)
1 4-way horizontal PC-mount 5.08mm pluggable terminal block header (Altronics P-2594, Jaycar HM-3104)
1 4-way screw terminal socket (Altronics P-2514, Jaycar HM-3124)
1 memory card socket (Jaycar PS-0024)

Semiconductors

1 PIC18F27J53-I/SP microcontroller (IC1) – from **www.microchipdirect.com**
1 2N7000 FET (Q1)
1 TPS61097-33DBVT boost regulator (REG1)
1 LM3940-3.3 regulator (REG2)
4 1N5819 diodes (D1-D4)
1 1N4004 diode (D5)
1 LED 3mm blue (LED1) (Altronics Z-0707, Jaycar ZD-0130)

Inductors

1 100µH choke (Altronics L-7034, Jaycar LF-1534)

Capacitors

1 47µF low ESR 63V
3 22µF tantalum
2 10µF tantalum
1 4.7µF tantalum
6 100nF monolithic
1 10nF greencap
2 33pF ceramic
2 12pF ceramic

Resistors (1%, 0.25W)

1 330kΩ	2 1kΩ
3 33kΩ	3 470Ω
2 15kΩ	2 10Ω
10 4.7kΩ	

In operation, the microcontroller checks the supply voltage on a regular basis. If the cells are "dangerously" low in voltage (indicating they have been discharged too much), the microcontroller goes into deep sleep mode.

Power supply options

The entire circuit of the USB Data Logger is powered from the 3.3V rail. This includes the microcontroller (IC1) and the memory card. However, while the microcontroller itself is powered by a 3.3V rail, its core runs from a 2.5V rail and this is derived using an internal low drop-out regulator. A 10µF tantalum capacitor on pin 6 (VddCore/Vcap) decouples this 2.5V rail.

When running from a battery, the +3.3V rail is regulated using REG1, a TPS61097-33 low-power synchronous boost regulator IC (made by Texas Instruments). This switchmode IC can convert an input voltage of between 0.9V and 3.3V into a regulated +3.3V rail and is capable of supplying up to 100mA.

Only three external components are required for REG1 – a 100µH inductor (L1) and two 22µF tantalum bypass capacitors (one across the input and one across the 3.3V output). The regulator itself comes in a SOT-23 5-pin SMD (Surface Mount Device) package. However, it's quite easy to solder in by hand.

This switchmode regulator has much better efficiency than a linear regulator and it allows the circuit to be powered from just two AAA cells.

This has four main advantages. First, cells are expensive, so using two rather than three decreases the cost. Second, using two AAA cells allows them to be trickle charged from a 3.3V rail since their voltage will not exceed about 2.8V when fully charged. Third, this allows us to use a standard double cell holder. Fourth, it keeps the unit small and light.

As mentioned previously, power can be supplied in three ways: (1) from two AAA cells; (2) from a PC via USB port CON2 (5V); or from an external 5-7V DC supply connected to pins 2 and 4 of CON3 (see Table 2). Switch S1 selects between either the USB power source or the external 5-7V source and either of these sources can recharge the battery (if rechargeable cells are used).

Regulator REG2 (LM3940IT-3.3) is used to reduce the USB or external supply voltage to 3.3V. This is a linear low drop-out 3.3V regulator which can operate from an input voltage as low as 4.5V. Its output is fed via Schottky diode D1 to the input of the switchmode regulator (REG1).

Low ESR capacitor

A 10µF tantalum capacitor decouples the input to REG2, while a 47µF low ESR (Equivalent Series Resistance) aluminium electrolytic capacitor is installed across its output, to ensure stability. Don't be tempted to use a common electrolytic here – it must be a low ESR type. The 1kΩ resistor to ground is there to provide a minimal load, while diode D4 provides reverse polarity protection when using an external supply.

Note that the input voltage at CON3 must be strictly between 5V and 7V DC (REG2 has a maximum input voltage rating of 7.5V). As such, you can use a 6V SLA (Sealed Lead Acid) battery or, if mains power is available, a regulated 6V DC plugpack.

If you want to use the data logger in your car (and don't want to use a battery), you can power it via a USB charger that plugs into your car's cigarette lighter socket and provides a regulated 5V.

Battery charging

The two rechargeable AAA cells provide power to the boost regulator (REG1) via Schottky diode D2. These will typically be rated at 900-950mAh and are trickle charged from the 3.3V output of REG2 via Schottky diode D1 and a 10Ω resistor while ever USB or external power is connected.

The value of this resistor is chosen so that the charging current is around 0.05C (where C is the capacity of the battery). This amount is considered safe for indefinite charging and fully charging a battery in this way can take up to 15 hours (you can recharge the cells more quickly by removing them and placing them in an external charger if necessary).

For 900mAh cells, a charge rate of 0.05C means a charging current of 900 x .05 = 45mA. From there, it's easy to calculate the required resistor value. Assuming that the voltage drop across D1 is 0.3V and that the average cell voltage is 1.25V, then the resistor value will be is (3 - 2.5)/0.045 = 11.1Ω.

A 10Ω resistor is the nearest preferred value.

Diode D2 is reverse biased during charging and only becomes forward biased when USB or external power is removed. **Note that if you are using non-rechargeable, alkaline cells, together with an external power source, the 10Ω resistor must be omitted to prevent charging.** In this case, D2 provides reverse polarity protection against a reversed battery connection.

The USB Data Logger can run for long periods on just two AAA cells – typically two to three weeks, depending on the logging frequency. However, for very long term logging without an external power supply, a 6V SLA battery rated at 12Ah will be required.

Pushbutton switch

Now let's consider the operation of switch S2. As shown, this momentary SPDT switch is wired in parallel with the lower 4.7kΩ resistor in the divider. Pressing this switch pulls IC1's AN4 pin to GND and this is detected by the microcontroller which then takes the appropriate action.

Basically, the firmware uses the output of an internal comparator to sense when S2 is pressed. The AN4 pin is also connected to the inverting input of an internal comparator, while the non-inverting input is connected to an internal voltage reference.

This voltage reference can be controlled by the firmware and is derived from IC1's supply voltage using an internal resistor ladder network. In this case, the threshold is set at around 0.4V by the firmware, so any voltage below this at the AN4 input switches the output of the comparator high.

Since there is a 2:1 voltage divider on this input, this means that the comparator output is low provided S2 is not pressed and the voltage at the input of REG1 is above around 0.8V. This should always be the case when the circuit is being powered, so the comparator output is normally low.

The comparator module is configured to generate an interrupt when its output goes from low to high. This occurs when S2 is pressed and starts a timer that measures how long S2 is held down.

The USB Data Logger recognises both a short press (less than 1s) and a long press (more than 1.5s). Once the key press is registered, the timer is shut down (to save power) and the firmware rearms the comparator interrupt after a hold-off delay.

In operation, long presses of S2 are used to start and stop the data logging. The short press is used to flash LED1 (blue) to provide operational feedback to the user. This LED is driven by the RC6 pin of IC1 as described previously, with a 470Ω resistor providing current limiting. We will describe its operation in more detail in Pt.2 next month.

Scripting Language

Finally, we've written a custom scripting language so that the USB Data Logger can be configured for use with a wide range of digital sensors. This also involves the use of a Windows-based host program that can parse this scripting language and compile it into "machine code". This is then programmed into the USB Data Logger's non-volatile memory (ie, into a file on the memory card).

The reason for this scripting language is to allow a wide range of digital sensors to be used with the data logger. Rather than designing it to work with a select few sensors, with the scripting language you can configure it to suit whichever sensor you would like to use, as long as it operates using one of the supported protocols (I^2C or Dallas One Wire).

Having written a script to suit your sensor, the resulting code is then executed by the microcontroller, allowing it to communicate with that sensor and read its output.

Next month

That's all we have space for this month. Next month, we'll give the full assembly details and describe how the USB Data Logger is used. SC

Biggest-WebShop-VHF UHF Standard BandPass Filter Temwell&Toko Type Alternative online- 72hr Shipping
Total 200Kpcs, 500 models, 2&3 tuning in Stock

① 7HW/ 7HT Toko 302MXP Type UHF (2/3 Tuning Filter)

TW-P/N-Fo-SW	TW-P/N-Fo-SW	TW-P/N-Fo-SW	TW-P/N-Fo-SW
K2B1-366M-10M	K2B1-555M-13M	K3BT-436M-20M	K3CT1-633M2-9M
K2B1-370M-10M	K2B1-528M-13M	K3BT-459M-20M	K3BT-609M-20M
K2B1-393M-10M	K3BT-378M-10M	K3BT-469M-10M	K3CT1-660-M-20M
K2B1-560M-10M	K3BT-378M-16M	K3B-485M-20M	K3BT-869M-20M
K2B1-410M-10M	K3BT-390M-10M	K3BT-510M-10M	K3CT1-804M-13M
K2B1-429M-11M	K3BT-390M-16M	K3BT-510M-16M	K3CT1-819-10M
K2B1-439M-11M	K3BT-410M-11M	K3CT2-600M-20M	K3CT1-838M-15M
K2B1-459M-11M	K3BT-410M-16M	K3BT-512M-16M	K3CT1-947M-15M
K2B1-460M-11M	K3BT-415M-16M	K3BT-551M-10M	K3CT1-949M-13M
K2B1-479M-11M	K3BT-415M-20M	K3BT-698M-13M	K3CT1-501M-25M
K2B1-490M-10M	K3BT-429M-16M	K3CT1-503M-10M	

② 7HW Toko 252MXPR Type UHF (2 Tuning Filter)

TW P/N-Fo-SW	Toko P/N	TW P/N-Fo-SW	Toko P/N
K2B-405M-20M	252MXPR-7255A	K3B-453M-20M	252MXPP-7267A
K2B-415M-20M	252MXPR-7233A	K3B-882M-20M	252MXPP-7273A

③ 5HW Toko type UHF Double Tuning Band Pass Filter

TW-P/N-Fo-SW	TW-P/N-Fo-SW	TW-P/N-Fo-SW	TW-P/N-Fo-SW
K2RB-369M-10M	K2RB-474M-11M	K2RB-637M-20M	K2RB-669M-20M
K2RB-393M-10M	K2RB-479M-11M	K2RB-638M-20M	K2RB-703M-20M
K2RB-415M-10M	K2RB-509M-14M	K2RB-795M-20M	K2RB-713M-20M
K2RB-425M-10M	K2RB-530M-14M	K2RB-829M-20M	K2RC-1195M-35M
K2RB-439M-10M	K2RB-545M-14M	K2RB-880M-20M	K2RC-1229M-35M
K2RB-450M-11M	K2RB-629M-14M	K2RB-914M-20M	K2RC-1309M-35M

④ 5HT Toko type UHF Triple Tuning Band Pass Filter

TW-P/N-Fo-SW	TW-P/N-Fo-SW	TW-P/N-Fo-SW	TW-P/N-Fo-SW
K3RT-360M-20M	K3RT-460M-18M	K3RBT-655M-18M	K3RT-649M-25M
K3RT-380M-20M	K3RT-480M-18M	K3RBT-705M-30M	K3RBT-663M-20M
K3RT-390M-20M	K3RT-490M-18M	K3RBT-755M-30M	K3RBT-703M-20M
K3RT-410-7M-18M	K3RT-510M-20M	K3RBT-800M-20M	K3RBT-709M-20M
K3RT-420M-18M	K3RT-518M-20M	K3RBT-830M-20M	K3RBT-720M-20M
K3RT-438M-18M	K3RT-540M-18M	K3RBT-862M-20M	K3RBT-729M-20M
K3RT-440M-18M	K3RT-590M-18M	K3RBT-880M-20M	K3RBT-733M-20M

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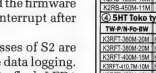
Temwell-VHF.UHF 5-20 Watts Diplexer



(5 Watts, 7H313) (10-20 Watts)

(EX) VHF.UHF 5 Watts Diplexer List (50Ω)

TEMWELL-s/n/ P/n	Fo./Fsr / L.95
DC2315-308M/334M-P	308/334 3.0/3.0
DC3315-308M/334M-P	308/334 3.0/3.0
DCN315-308M/334M-P	308/344 3.0/3.0
DC-TL-T-27M/33M-P	27M/33M 3.0/3.0
DDO450M/465MP	440/465M 3.0/3.0
DDO450M/479MP	440/479M 3.0/3.0
DDO335-450M/476MP	450/476M 3.0/3.0
DDO335-450M/490MP	450/490M 3.0/3.0
DDN335-450M/476MP	450/476M 3.0/3.0

(EX) VHF.UHF 10-20 Watts Diplexer List (50Ω)

TEMWELL-s/n/ P/n	Fo./Fsr / L.95
DIAN 128/148M SMA	128/148M 1.0/1.0
DIAN 148/168M SMA	148/168M 1.0/1.0
DIAN 148/168M SMA	148/168M 1.0/1.0
DIDS 300/320M SMA	300/320M 1.0/1.0
DIDS 320/340M SMA	320/340M 1.0/1.0
DIDS 330/350M SMA	330/350M 1.0/1.0
DIDS 410/440M SMA	410/440M 1.0/1.0
DIDS 440/465M SMA	440/465M 1.0/1.0
DIDS 450/490M SMA	450/490M 1.0/1.0
DIDS 450/465M SMA	450/465M 1.0/1.0
DIDS 450/480M SMA	450/480M 1.0/1.0

See more BW& Perf-Spec: www.temwell.com.tw

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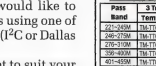
BW (-3dB): 40-65MHz; UHF: Fo: 210~1.3G
IL: 1.5~2.5dB; Group delay: 30~40 nsec
Designed 4 type BW of: 8-20/20-40/40-60/60-100MHz...etc



Pass Band	3 Tuning (7H3 series) Temwell-P/N-Fo-BW	IL	4 Tuning (7H4 series) Temwell-P/N-Fo-BW	IL
72~249M	TN-T1673868-249M-40MN	2.0	TN-T1685236-249M-60MN	2.5
246~278M	TN-T1672735-259M-35MN	2.0	TN-T1674217-264M-60MN	2.5
270~310M	TN-T1677278-293M-40MN	2.0	TN-T1684393-329M-60MN	2.5
306~403M	TN-T1677276-378M-40MN	2.0	TN-T1684295-378M-60MN	2.5
401~459M	TN-T1677268-427.5M-40MN	2.5	TN-T1684298-459M-60MN	2.5
459~519M	TN-T1678118-489M-40MN	2.0	TN-T1679737-470MnMin	2.5
519~599M	TN-T1678128-559M-40MN	2.0	TN-T1682755-519M-60MN	2.5
590~699M	TN-T1678233-589M-40MN	2.0	TN-T1688218-597M-40MN	2.5
696~806M	TN-T1678269-833M-40MN	2.0	TN-T1679833~680M-58MN	2.5
801~707M	TN-T1683868-804M-40MN	2.0	TN-T1679833~660M-58MN	2.5
701~792M	TN-T1672304~730M-40MN	2.0	TN-T1686828-729M-58MN	2.5
751~830M	TN-T1677278-779M-50MN	2.0	TN-T1686828-779M-58MN	2.5
801~833M	TN-T1678048-819M-60MN	2.0	TN-T1686931-825M-60MN	2.5
831~890M	TN-T1675196-850M-70MN	2.0	TN-T1674217-845M-70MN	2.5
1001~1030M	TN-T1673414~1030M-70MN	2.0	TN-T1673414~1030M-70MN	2.5
1251~1300M	TN-T1683968-1268M-100MN	2.0	TN-T1684948-1268M-120MN	2.5

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SERVICEMAN'S LOG

Hair today, gone tomorrow

Items Covered This Month

- The dodgy skin analyser
- McIntosh PF-2520i car stereo
- Messing about with boats

Beauty may only be skin deep but it takes machines (and a whole industry) to maintain it. Too hairy? Zap! – problem fixed. But who fixes the machines when they stop working?

My first story this month comes from G. M. of Pukekohe, NZ. He's generally involved with A/V gear but doesn't hesitate to take on other service jobs in order to make a dollar. Here's his story . . .

While most of my work is related to audio/video servicing, I am also often asked to look at other items. I usually quite enjoy doing this as it keeps me interested and challenged and it is amazing how it can broaden your knowledge base. Some of what you learn on one item can lead to a "light bulb" moment on a completely unrelated item.

Apart from the usual DVDs, VCRs and hifi equipment, I have also repaired electric fences, wheel balancers, carrot packers, spray robots and forklift drives and chargers – plus many other items related to the automotive and light industry sectors. Some of the equipment is worth tens of thousands of dollars to replace, so the owners are usually grateful to have the item fixed, almost regardless of the cost of the repair.

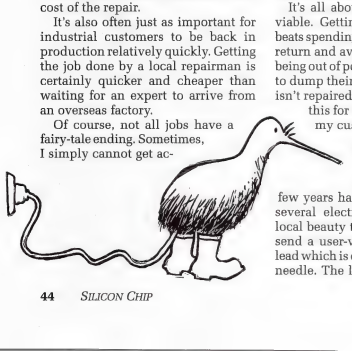
It's also often just as important for industrial customers to be back in production relatively quickly. Getting the job done by a local repairman is certainly quicker and cheaper than waiting for an expert to arrive from an overseas factory.

Of course, not all jobs have a fairy-tale ending. Sometimes, I simply cannot get access to the necessary information or spare parts to repair specialised equipment. Fortunately, over the years, I have honed my instincts so that I can usually spot a "don't-bother-going-there" job before getting in too deep. I also make it very clear that there will be a minimum charge of $50-100 regardless of the outcome and there is rarely a quibble from the customer.

This allows me to spend enough time with the gear to determine whether I should become further involved or not.

I also ask for a $50 non-refundable deposit for every job that comes into my workshop. This helps to sort the wheat from the chaff, not only in respect of the faulty item but also the owner. It is amazing how many people expect you to "just take a look at it" for nothing. I learned long ago that if you get a monetary commitment at the beginning, they are more likely to say yes to an estimate and after the repair, they are more likely to collect it and pay the balance.

It's all about making the business viable. Getting an up-front fee sure beats spending my precious time for no return and avoids the added insult of being out of pocket when it comes time to dump their junk at the local tip if it isn't repaired. In fact, I've been doing this for so long now that most of my customers now expect it.



Electrocuting hairs

One of my more unusual jobs over the past few years has involved the repair of several electrolysis machines for a local beauty therapist. These devices send a user-variable voltage down a lead which is connected to a very sharp needle. The latter is used to pierce a hair root and the voltage kills it.

The electrical circuit is completed by the "hairy" person holding a metal rod. This rod is covered with a damp sponge and is wired back to the earth of the waveform generator.

The devices are somewhat "technical" to operate, as they have two analog meters and a number of switches and controls to adjust to set everything correctly for the task at hand. They also have a small vacuum pump connected via a tube to the probe which gently removes the offensive odour of burning hair from under the therapist's nose.

I guess the therapists are well-schooled in the machine's operation and probably have certificates to prove it. I'm just thankful that, being a bloke, I don't feel pressured by fashion to have to undergo such torturous treatment although I am aware that some "blokes" do. I also have to admit to being appreciative that the lady in my life chooses to undergo such treatment.

The machines seem to be well-constructed and are perfectly safe. Most of the faults have simply been frayed wiring at the probe end, caused by continuous movement during operation. They can be a bit of a challenge to repair though, as the wire runs inside a small-gauge rubber vacuum hose.

Skin analyser

Although the electrolysis machines are well made, the same could hardly be said for another machine the same therapist asked me to look at recently. It was an unbranded "skin analyser" and it consisted of a metal cabinet the size of a small suitcase which housed six small UV fluorescent tubes (they call them "blue lights", as any mention of "UV" might upset the customers). In operation, the "patient" sits on the UV side with a dark cloth over their head while the therapist peers through a magnifying lens on the other side

and notes all the skin "defects" which need attention.

The device had stopped working and, according to the owner, was tripping the switch board circuit breaker. After collecting it for attention on the bench, I gave it a quick visual to see if there were any blown fuses or evidence of arcing or flashover. There was an in-line mains fuse at the bottom of the cabinet but it checked OK so rather than plugging the analyser in and risk powering down my own workshop, I connected my trusty Megger in turn between the Active and Neutral pins of the mains plug and the metal handle atop the cabinet. This test showed no problems.

Note, however, that I didn't carry out an earth continuity test at this point. I should have.

Casting caution to the wind, I gingerly plugged the unit in and switched it on at the socket. I was greeted with a crackling noise and some of the fluoros were attempting to work but the starters were flickering and were not completing their switching action. What's more, the unit's on-off switch didn't work. The power was on even when the mains switch was off!

It was not too difficult to expose the wiring for closer analysis. In fact, I was a bit concerned at how easy it was. If anyone had been determined enough, they could have quite easily poked their hand into the machine and contacted live connections!

The bottom of the cabinet was filled with six small ballasts for the tubes and the starters were mounted wherever there was space up the sides and amongst the tubes. All the ballasts were connected by wires at each end which were soldered to tags, with no attempt made to insulate the connections. But there was worse to come!

I dug deeper to get to the mains lead and on-off switch. Since the fuse was intact, I suspected there had to be a problem before the fuse. The earth connection seemed sound but I was astonished to discover that the plastic single-pole rocker switch and in-line fuse were in fact wired to the Neutral input, while the Active (Phase in NZ) was permanently connected to the rest of the circuit. There was nothing to suggest this had been done after it had come out of the factory.

So for all the years that this machine had been in use, 230V was still present throughout the machine even after it had been switched off using its main switch. But wait, there's more!

I tested the switch contact resistance, as arcing was a possible cause of the sizzling noise and the reduced voltage which was preventing the starters from completing their cycle. The switch tested OK but then I discovered that it even checked OK in the off position!

My next step was to disconnect all six lamp circuits and then test each in turn with the Megger. Bingo! One of the ballasts had gone "leaky" to its metal core.

From there, it wasn't difficult to explain why the unit couldn't be switched off. The Active was permanently connected and the circuit was being completed through the leaky ballast and then via the earth wire to the MEN link in the switchboard. However, the arcing short within the ballast was introducing enough resistance to prevent the full mains voltage from being applied to the lamps and the starters.

In fact, this was a graphic demonstration of the value of earth leakage protection devices as there was not

Would You Like To Be The New Serviceman?

Our regular Serviceman of many years has retired and we need a replacement. If you are doing regular service work and would like to take over the column, please contact Leo Simpson by emailing **editor@siliconchip.com.au**

We also welcome reader contributions for Serviceman. If you have any good servicing stories that you would like to share, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics or electrics.

We pay for all contributions published but please note that your material must be original. Send your contribution by email to **editor@siliconchip.com.au**

350/250/150MHz Digital Storage Oscilloscope GDS-3000 Series

With 5GSa/s sampling and VPO technology (Visual Persistence Oscilloscope) , GDS-3000 Series displays waveforms truthfully and captures less-frequently-occurred signals , like glitches or runts , simultaneously without missing any spot of waveform information.

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enough fault current to trip the old-style circuit breaker on my workbench. As a result, I made a mental note to install an ELB (or RCD) for my bench but isn't it strange how mental notes are usually never acted on!

Further investigation revealed that another two ballasts had gone open circuit. I removed these for closer inspection and quickly spotted the problem. A dab of glue had been applied to the very fine wire where it exited the former, presumably to provide some protection during assembly and eventual soldering to the tag. This glue has proven to be a ticking time bomb in many appliances, as it slowly eats away at the enamelled copper wire. In fact, in some appliances, the glue changes its composition to the extent that it becomes conductive and so another job comes in the door!

I prepared an estimate to replace the ballasts, correct the wiring and supply a couple of new lamps and then phoned the owner. She was unexpectedly pleased and asked me to continue. I understood her delight when she told me that she had paid nearly $2000 for the analyser. My opinion is that it could sell for well under half that price while still allowing healthy mark-ups for all in the supply chain.

Anyway, I duly ordered and fitted the new parts, rewired the mains lead and redressed some of the wiring to make everything a bit tidier. One unexpected additional task involved adjusting most of the contacts in the cheap lamp bases, to ensure that the lamps were held securely.

With the new lamps fitted, I applied power and was rewarded with a wash of blue light from the cabinet. Placing my hand into the light and looking through the lens made me aware of how important this device was to the therapist as it showed every blemish, freckle and scar I had collected over the years. Thank goodness the UV in our daylight is suitably diluted by all the other wavelengths!

I was not out of the woods yet, however! There was one final test to go and that was a safety test to verify the unit's earthing and isolation. This time, I checked the earth continuity first and since the unit was now fully assembled, I again went for the metal handle as the obvious connection point for the cabinet. Imagine my surprise when the test showed no continuity between the earth pin on the mains plug and the cabinet.

I had already checked the earth connection visually from the mains lead to the base of the metal cabinet and was satisfied that this was good. To cut an already long story short, the problem was that earthing for the upper part of the cabinet relied on eight screws which secured the top to the base. However, both sides of the cabinet had been painted (probably dipped) with a good enamel and this had served to insulate the screw connections.

Not one screw had "bitten through" this enamel to provide an earth connection and, in fact, the paint even lined the screw hole. Now I know why the original leakage test with the Megger didn't show up the shorted ballast.

Running a separate earth wire to the cabinet top fixed the problem.

Thankfully, this was the only such analyser my customer owned but I shudder to think how many others are still out there in daily use.

McIntosh PF-2520i car stereo

This next story is from another kiwi, J. L. of Blenheim, New Zealand . . .

A few months ago, I obtained a McIntosh PF-2520i-A car stereo. These units are actually manufactured by Clarion in Japan and are designed for high-end versions of the Subaru Legacy. It was only available in North America and features an internal 6-disc CD changer.

It is also somewhat unusual in that it has no internal amplifier and relies on a separate power amplifier fitted under the driver's seat of the car.

Unfortunately, when I unpacked the unit and powered it up on the bench, I was greeted by a display full of random garbage and little else – much to my dismay. Pressing buttons on the front panel had little effect except occasionally changing the layout of the garbage.

My choices were either to send it back to the US (and risk never seeing it or my money again) or have a go at fixing it myself. I chose the latter and a quick trawl around the internet revealed a service manual which could be downloaded for $5.

After poking around the main PC board, I soon discovered that the SYS+5V rail was down to a measly 2.5V. This supplies the VFD display driver IC (IC2) as well as various other sections of the unit. No wonder the display was misbehaving!

The SYS+5V rail is supplied via transistor Q451 which in turn is switched on via Q452 by microprocessor IC200. With power applied, there was 5V at Q451's emitter. What's more, Q452 appeared to pull Q451's base to ground as expected (via resistors R453 & R454) but Q451 simply refused to play along.

Unfortunately, I didn't have a spare 2SB1240 on hand but some quick research revealed it to be a medium-power general-purpose PNP transistor. I had a TIP32 in the junk box that seemed a close enough match and so I duly fitted it.

I switched on and was met with exactly the same problem! The SYS+5V rail refused to budge from 2.5V. Feeling somewhat frustrated, I removed the replacement transistor and shorted its collector and emitter pads on the PC board. The unit burst into life and all appeared to be well.

Next, I refitted the TIP32 (I had damaged the original transistor during removal) and shunted its base to ground with a 1kΩ resistor. The unit once again came to life and worked normally. I then replaced Q452 (2SC7212) with no success and found that diode D452 and all the surrounding SMD resistors checked OK.

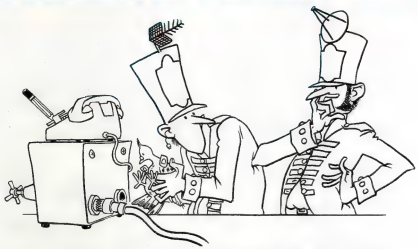
So what was left? After banging my head against the wall, I eventually stumbled across the problem. When desoldering R453 for checking, it had appeared to lift off the board a little too easily. Closer inspection revealed that the solder pad at one end of this tiny SMD resistor had cracked on all sides and separated from its track – something that had been impossible to spot until the resistor had been removed.

This had the effect of disconnecting Q451's base from the circuit and leaving it floating. As a result, I removed both resistors and replaced them with regular 470Ω 0.25W types, taking care to bridge the cracked track with solder in the process.

However, the story doesn't end there! After reassembling the unit, I discovered that CDs would not play. Removing the cover revealed that the disc wasn't spinning, although a slight twitch indicated that it was at least attempting to start.

Closer inspection revealed that the spindle had slipped down on the motor shaft and was jammed against the motor mounting screws. The spindle height is quite critical to reliable operation of the player so some trial and error was required to get it back into the correct position.

Once this was fixed, the unit performed very well indeed. I also tweaked the tuner to operate better in NZ by moving resistors R207-R209, R211 and R212. This modification causes the unit to tune in 100kHz steps on the FM band and 9kHz steps on the AM band, instead of the 200kHz and 10kHz steps used in North America.



"RUM CORP PTY LTD" WOULD HAVE FITTED SOMETHING IN "THAT HOLE" IF IT NEEDED IT

Although it looks very tidy I suspect that this particular unit has suffered a significant physical shock at some point in its life. This may have occurred during shipping or it may have been salvaged from a vehicle that had been involved in an accident.

Messing about in boats

An now for a change of scene, here's a story from S. J. S, of South Australia concerning a marine transceiver . . .

I am not an electronics serviceman but a retired chap who likes playing with his boat, a 56ft (17-metre) displacement trawler some three years old.

As a young man, I dabbled in amateur radio, back when things glowed in the dark and messages went out at a creaky 10-12 wpm (words per minute), at best, from my key (they always seemed to come back faster!). So although I'm no expert, I do have some technical background.

My boat has a "wireless station" consisting of two VHF Class-A DSC-capable transceivers (Icom IC–M604) and a HF Class-A DSC-capable transceiver (Icom IC-M801, 125W PEP with AT141 automatic aerial tuner and whip). There's also a satellite phone (KVH) with a tracking dish in a dome. (Note: for those not familiar with the term, DSC stands for "Digital Selective Calling". It's basically an automated paging system that's used to send distress alerts. At the touch of a button, it sends the boat's identity, its position and the nature of the problem. The alert will then be heard immediately by all DSC-equipped vessels and shore stations within range and is repeated every four minutes until it is acknowledged.)

All the above units are interfaced to the GPS system for UTC time and position data and can send position reports and distress messages via the DSC function. These set-ups cost some $18,000 plus installation. However, in my case, I was able to install and test the gear myself over a period of several weeks. It was lots of fun and saved the pennies.

Recently, I was proudly showing a visiting boatie over my boat. He had just travelled 1500 nautical miles from NSW in an "as new" 65 footer! When we came to my "wireless" setup he looked it over and told me he had the same make and model of HF in his boat. He also said that the DSC was totally useless and he was going to replace the HF with a "better brand, which would work".

As he was heading around Australia he wanted "good gear".

I suggested that the set he had was as good as it gets unless you buy full commercial gear. I also told him that based on my own experience, it should work very well. His reply was that the company in NSW that had installed the gear (let's call them "Rum Corp Pty Ltd") had told him that DSC is useless and never works!

Now a cynic would say that "one volunteer is better than a hundred pressed men". You guessed it – I volunteered to have a look at it for him on the basis that "mine works fine and it could be something simple!"

A few quick questions soon revealed that he could send a DSC message but that he never got a reply. He had checked with the base station that they could receive his messages and they insisted that they were sending replies – which he never got.

As a result, we sent a test message and the screen indicated it had been sent. But he was correct; there was no acknowledgement from the base station.

At this point, I asked to be taken to the transceiver which was handily located in the dim recesses of a locker at deck level (a real "no-no" in a boat)! The installation, while not perfect, looked reasonable but something was not quite right. On the back of the set are two PL259 sockets, each clearly labelled. One PL259 socket was labelled "Output to aerial tuner" and a coax lead was attached to it. The other was labelled "DSC aerial" but there was nothing attached!

Despite this, the owner was unimpressed with my discovery, telling me that "Rum Corp Pty Ltd" would have "fitted something in that hole if it needed it". Clearly the set was no good and I was a goose and didn't know what I was talking about – or so he implied.

I wasn't going to take that. I come from a state settled by free men, not convicts – no Rum Corp for us! As a result, I made up a PL259 plug patch lead and connected his existing AM/FM whip, some 2.4m long, to the empty socket. There was no cutting of wires – it was simply a matter of unplugging the whip from his AM set and plugging it into the DSC socket.

A test signal was then sent and an acknowledgement was immediately received! And so it really was something very simple after all. I gave him the name of a good local technician to tidy up the job before he set out across the Bight.

And what does the installation manual say in BIG print? . . . "Do not forget the DSC HF receive aerial or no DSC can be received".

A funny thing that! I also spoke with a local radio installation sparky and he told me he had struck exactly the same problem on another boat from the East. Must be something in the water over there! SC

Merry Christmas From the Jaycar Team

Home Theatre PC Remote Control

Simply plug in the USB dongle and away you go. All the mouse functions are controlled by a state-of-the-art fibre optics. It also includes Windows hot keys and all the TV functions as well.

- Compatible with Windows 2000, XP, Vista, 7
- Dimensions: 200(L) x 65(W) x 22(H)mm

XC-4939

$99.00

In-Car Laptop Power Supply

Automatic power supply for smaller laptops. Simply connect to your car's cigarette lighter socket and select the plug that fits your computer. Suits most laptop models. See website for compatibility

- Input voltage: 12VDC
- Power output: 90W
- Output voltages: 15 - 24VDC
- 16 plugs
- Dimensions: 95(L) x 62(W) x 35(H)mm

MP-3324

$59.95

Touch Screen LCD Monitors with USB

Touch screen capabilities enables use with a laptop/PC, games console and endless other VGA operating devices. Use it to control a computer or any other USB compatible device. The monitor can be mounted either on the bracket or flush mounted with cradle. Software and adaptor cables included.

7" Touch Screen LCD Monitor

- Dimensions: 178(W) x 122(H) x 30(D)mm

QM-3744 $249.00

12" Touch Screen LCD Monitor

- Dimensions: 308(W) x 208(H) x 32(D)mm

QM-3746 $399.00

FROM **$249.00**

DAB+/FM Digital Radio Kit

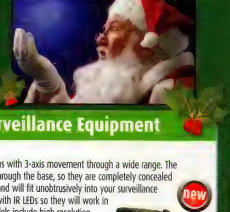
There are very few digital radios available as hi-fi components and the few that are cost north of $700. Many hi-fi enthusiasts want to add a digital tuner to their system and want function and sound quality over bells and whistles. It covers DAB+ and FM, has analogue and optical audio outputs, IR remote (optional extra), an external antenna connector and is powered by a low-cost mains plugpack. The kit is complete with everything, including the case. See website for full specs.

- Digital station info display
- RCA and optical audio output
- External antenna connection
- Station memory presets
- Requires mains plugpack

KC-5491

Not Available in NZ

$399.00



Ultrasonic Antifouling for Boats

Many of you know that you can buy $3-8,000 imported marine growth electronic antifouling systems. Jaycar, with Silicon Chip have developed a similar system based on this technology and information in the public domain. This project uses the same ultrasonic waveforms and virtually identical ultrasonic transducers mounted in sturdy polyurethane housings. By building yourself (which includes some potting) you save a fortune! Standard unit consists of control electronic kit and case, ultrasonic transducer, potting and gluing components and housings.

Research reveals only one transducer is needed for boats under 32ft. Basically all parts supplied in the project kit including wiring.

- 12VDC
- Suitable for power or sail
- Could be powered by a solar panel/wind generator
- Available end of October - call first for availability
- Price includes epoxies

KC-5498

$249.00

Remote Control Heaven

Remote Control Hovercraft

Capable of ridiculous speeds, massive power slides and high speeds drifts. Two brushless ducted fan motors are responsible for the power, one blowing downwards to generate lift, and the second (and more powerful) motor providing the forward thrust. Uses tough abrasion resistant polyethylene foam as a kind of "skid" platform so that the whole craft semi-floats just above the ground when power is applied.

- 2.4GHz RC unit included
- Li-Po battery and charger included
- Suitable for ages 8+
- Dimensions: 193(L) x 280(H) x 113(W)mm

GT-3740

$249.00

4 Channel RC Helicopter

Ideal for the advanced pilot this beauty gives you full control in all directions via the 4 channel 2.4GHz remote, allowing you to control the elevation, up, down, forward, back, bank left, bank right and left/right rotation. That means you can fly like a true chopper ace with all the moves and tricks. 20 minutes charge gives about 10 minutes flight time.

- Chopper battery: 7.4V Li-Po 1000mAh
- Size: 360(L)mm approx
- Suitable for ages 10+
- Remote unit requires 8 x AA batteries

GF-3340

$179.00

New Surveillance Equipment

IP68 3-Axis Cameras

High quality IP68 rated cameras with 3-axis movement through a wide range. The power and video cables exit through the base, so they are completely concealed from prying cutters. Compact and will fit unobtrusively into your surveillance setup. They're also equipped with IR LEDs so they will work in the dark up to 20 metres. Models include high resolution 550TVL, an economical 380TVL and a dummy camera that has been made using genuine components (housing, LEDs, lens etc.) so it looks identical to the real thing when installed.

3-Axis Outdoor IR Camera 380TVL QC-8611 $129.00
3-Axis Outdoor IR Cameras 550TVL QC-8612 $249.00

3-Axis Colour Dome Cameras

3-axis mechanism provides easy installation and enables you to put the camera's field of view exactly where required. Models include high resolution 550TVL and economical 380TVL.

Dome Camera 380 TV Lines QC-8616 $99.00
Dome Camera 550TV Lines QC-8617 $199.00

FROM **$99.00**

Network 4 Channel H264 DVR

A combined multiplexer and digital video recorder that delivers quality image reproduction at a touch of a button. It will accept up to 4 video inputs and its incorporated Ethernet capability so it can be accessed (with password protection) via the Internet by a standard web browser. Also access footage on your iPhone® or other smart phone after downloading the compatible app. The unit features H.264 compression, VGA monitor connection, motion trigger recording, video loss detection, remote network record and USB back-up support. The unit comes fitted with a 500GB HDD and includes software & manual disc, power supply and quick start guide. See website for full specifications.

QV-8105

$399.00

www.jaycar.com.au

To order call 1800 022 888

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Secure Your Home this Christmas

DVR Kits

Budget Four Channel Digital Video Recorder

This system allows you to monitor and record 4 locations at your home or office. This great value digital video recorder (DVR) package can store over 150 hours of video on the installed 250GB hard drive. Recording set-up is simple and various trigger modes can be set across the day including timer, motion detection, and manual recording.

The system comes complete with:
- 4-channel DVR with 250GB HDD, USB port, and 1 x composite video output
- 4 x weather resistant colour day/night cameras
- Plug-in interconnection cables
- Remote control
- Mains adaptor and user manual

QV-3063 WAS $599.00

$499.00
SAVE $100.00

Network 4 Channel H.264 DVR / Camera Kit

Includes a multiplexing DVR system with H.264 compression technology complete with four colour IR outdoor CCD cameras, four 20 metre pre-wired camera cables and power supply. Everything you need and easy to install. The DVR is fitted with a 250GB HDD plus built-in Ethernet capability that enables the unit to be accessed (with password protection) via the Internet using a standard web browser. The recorder features advanced motion trigger recording, video loss detection, remote network record and USB back-up support. Just add a TV or monitor for a complete surveillance system.

- Camera Dimensions: 116(L) x 60(W) x 79(H)mm
- DVR Dimensions: 343(W) x 59(H) x 223(D)mm

QV-8100 WAS $799.00

$699.00
SAVE $100.00

Mini DVR Kit with Button-Hole Camera

new

Capture meetings, conferences or lectures with this high definition video and audio mini DVR kit. Will store up to 32GB on an SD card, then allow video viewing on the 2" TFT LCD screen or download to a PC. The kit includes a pinhole camera with different buttonhole options so it's completely covert and discreet. Also includes a Li-Ion rechargeable battery, charger, AV leads, USB cable, software and dummy buttons for disguising the camera.

- Recording resolution: Up 720 x 576
- Approx 10 hours of video
- 128MB flash memory
- Camera resolution 420TV lines
- Windows XP, Vista, 7 compatible

Dimensions:
DVR: 65(W) x 54(H) x 14(D)mm
Camera: 22(W) x 34(H) x 15(D)mm
QC-8006

$249.00

Gooseneck USB CMOS Inspection Camera

new

Hundreds of applications for this gooseneck camera, including checking under vehicles, inside cupboards, behind wall cavities, inside engines, up chimneys etc. The camera head has built-in LEDs with variable brightness control. Also included is a magnetic attachment. Completely portable and powered by USB.

- Drivers included
- LED illuminators
- Dimensions: Camera head: 62(L) x 14(Dia)mm Gooseneck: 580(L) x 9.5(Dia)mm

QC-3388

$99.00

Solar Powered Mini Window Alarms

Simply peel the clear backing from the self-adhesive mount and position on a window - no tools required. The solar cell keeps the built-in Ni-MH battery charged and if triggered, the very loud alarm sounds. Two types are available: one is a glass breakage and vibration sensor, the other is a magnetic reed switch. Suitable for windows, French doors, sliding glass doors and pane glass doors.

- Warning sticker included
- No wiring
- Never needs batteries
- Self-adhesive
- 3 year warranty
- Size: 70(W) x 82(H) x 8(D)mm

Mini Glass Breakage/Vibration Window Alarm LA-5003
Mini Magnetic Entry Alarm LA-5005

BOTH
$24.95 ea

new

2.8" TFT LCD Monitor & AV Recorder

The smallest and lightest LCD monitor/recorder on the market with a multitude of applications. Monitor CCTV cameras, record audio and video to an SD card or use it for playback either through the unit or via the AV out to an external monitor or TV. Rechargeable and ultra-portable, complete with AV lead, instruction manual and charger.

new

- 2.8" LCD
- 480 x 234 pixel resolution
- Built-in rechargeable battery
- Dimensions: 88(L) x 58(W) x 17(D)mm

QM-3824

$149.00

Dummy Cameras

Dummy IP68 3-Axis Camera with Concealed Cable Bracket

new

High quality IP68 rated camera with 3-axis movement through a wide range. Very compact so will fit unobtrusively into your surveillance setup.

- Equipped with IR LEDs
- 20 metre range

QC-8610

$49.95

3-Axis Colour Dome Camera

new

It's constructed using genuine components (housing, lens, etc.) which is indistinguishable from the real thing once installed. With a 3-axis mechanism that provides easy installation and enables you to put the camera's field of view exactly where you need it.

QC-8615

$39.95

Four Zone Security Alarm with 2 Wire Technology

new

Four Zone Security Alarm System with 2 Wire Technology
A simple DIY alarm. All system components (sensors, sirens) are connected to the control unit via a two core flat wire. The unit has a built- in keypad with status LED and three modes of operation (Home, Out, Off). All sensors and sounders are line protected so any attempt to interfere will sound the alarm.

Supplied with:
- Four-Zone system to set up multiple zones which can be monitored or enable independently (i.e. upstairs/downstairs or house & garage etc.)
- Main control unit
- Two PIRs
- Four door or window contact switches
- External switch
- 240VAC Adaptor
- 50m two-core flat wire clips
- Screw/wall plugs
- Main unit: 160(Ø(W) x35(D)mm

LA-5475

$149.00

Accessories sold separately
Extra PIR with dual-element passive infra-red intrusion detector LA-5476 $29.95
A long range curtain lens with a vertical beam LA-5473 $6.95
Pet Alley Lens - Allows pets to move around in a protected area without setting off the alarm LA-5471 $6.95

8 Zone Wireless Alarm Kit

This alarm kit features key fob remote control, backlit LCD control panel with three colour-coded indicators of system status. Everything you need to get a basic wireless system in your home or office is included in the kit, with spare sensors available so you can expand the system as you need to.
Package includes:
- PIR sensor
- 2 x reed switch sensors for doors or windows

Features:
- 8 zones
- 4 operation modes
- Low battery indicator
- Back-up battery

LA-5145

$179.00

Spare sensors and accessories also available, see website for details.

12V Outdoor Siren / Bellbox

Bellbox and siren for outdoor use. Important visual deterrent factor in any security system. 12V operation, so will happily work with a range of different alarm systems. Anti-tamper switch included.

- Operating voltage: 12VDC
- Current consumption: 300mA
- Dimensions: 202(W) x 112(H) x 65(D)mm

LA-5301

$29.95

Great Christmas Gifts for the Computer Addict

Plug & Play MPEG-4 IP Cameras

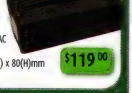
Unlike other IP Internet cameras on the market you don't need to worry about DDNS settings and NAT IP mapping. Not only are they easy to install, they feature high resolution 640 x 480 pixels, have built in microphone for audio monitoring, & allow you to control up to 16 cameras through the included software. With easy access to the camera via the web service, all you need to do is plug it in & play! So simple!

Two models available:
IP Camera QC-3397
WAS $199.00 NOW $159.00 SAVE $40.00
Wireless IP Camera QC-3399
WAS $249.00 NOW $199.00 SAVE $50.00

FROM **$159.00**

600VA 375W Line Interactive UPS

Compact and completely self-contained, this is the ideal backup solution for data or other important equipment. It has 3 surge-protected outlets as well as 3 outlets backed up by the UPS. It also has RJ11 ports for protecting phone or fax lines.



- Software included
- Rating: 375W, 600VA
- SLA battery: 7Ah
- Supply voltage 220 to 280VAC
- Recharge time: 10 hrs
- Dimensions: 268(L) x 180(W) x 80(H)mm

MP-5222

$119.00

70W Universal Automatic Laptop Power Supply

Has adaptors to fit most major manufacturers' DC power input sockets, and enough power to suit most demanding laptop models.

- Power output: 70W
- Voltage range: 8.4 - 24VDC
- 16 different connectors
- Automatic selectable voltage
- Dimensions: 110(L) x 52(W) x 25(H)mm

MP-3320

$59.95

5.5" Graphics Tablet

The pen has user defined buttons and "hotspots" around the border of the tablet. Paint, draw, write or touch up. Absolutely essential tool for graphics designers or photographers etc.

- Battery and software included
- Windows 2000, XP, Vista or Mac
- Dimensions: 205(W) x 190(H)mm

XC-0356 WAS $79.95

$59.95 SAVE $20.00

USB Digital TV Stick

Digital TV on your PC and a bundle of extra features including Picture-in-Picture, still and video image capture and much more. Easy to install and use and no bigger than a USB stick.

- Digital TV and radio program recording
- Real-time video recording
- Still image capture
- Picture-in-picture function
- One-touch channel scan
- Multi-lingual installation

XC-4888

$49.95

Not available in NZ

Networking USB 2.0 Servers

Hardwired PC peripherals can be difficult to share from one computer to the next. Bypass the complication and access USB devices directly through the network. Plug this device into the router with the supplied Cat 5 cable then plug in a USB powered product and computers will be able to see and use the USB peripherals from any computer.

1 Port YN-8400 WAS $79.95
Also available:
4 Port YN-8404 WAS $99.00
NOW $79.00 SAVE $20.00

$59.95 SAVE $20.00

4 Port Coloured USB Hub

Brighten up your workspace with five bright colours on your USB hub. Each different coloured port can rotate 180° for easy connection to USB devices positioned on either side of the hub.

- USB 2.0 compatible
- Windows 2000, XP and Vista compatible
- USB lead included

XC-4300

$19.95

PC & Laptop Accessories

Combination Notebook Cable Lock

This laptop security cable has a four digit combination that you can customise for security. It's 1.8m long and has a swivel on the end so moving it around your desk area will not be a problem.

- 1.8m long
- 4 digit combination
- Steel lock mechanism

XC-4639

$17.95

Rhinestone USB Keyboard

She has style, she has flair, now Mum can have the keyboard to match. Features 21 hot keys including 3 ACPI keys for easy access to the internet, email and multimedia applications.

- Compatible with Windows 95/98/ME/NT/XP
- Dimensions: 460(L) x 180(D)mm

GH-1899 WAS $59.95

$49.95 SAVE $10.00

Active 2 Way Standing Speakers

These speakers are a great way to project sound from a PC, iPod®, MP3 player or mobile phone. Easily accessible volume and treble controls, simple plug and play functionality make these speakers an ideal and affordable audio solution.

- Power nominal: 5WRMS
- Driver size: 3"
- Dimensions: 235(H) x 74(W) x 54(D)mm

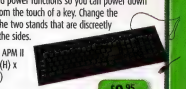
XC-5181

$24.95

Computer Needs

Black QWERTY USB Keyboard

This incredibly flat and light QWERTY keyboard includes wakeup sleep and power functions so you can power down your computer from the touch of a key. Change the inclination with the two stands that are discreetly tucked away on the sides.



- Supports API or APM II
- Dimensions: 20(H) x 452(L) x 161(W)

XC-5146

$9.95

Wireless Trackball Keyboard

Control everything from the couch! The trackball and scroll wheel take the place of a mouse and the left and right mouse buttons are located on top as well as under the keyboard so it can used like a games console.

Simply plug in the USB wireless receiver to a PC and it's ready to be used.

- 2.4GHz with 8 channels
- 10m range
- Windows XP & Vista compatible
- 12 Internet/multimedia hot keys
- Integrated optical trackball & scroll wheel
- Requires 4 x AA batteries

XC-4941 WAS $99.00

$89.00 SAVE $10.00

Wireless USB Trackball Remote Control for PC

The trackball works as a mouse or any other pointer device and can type numbers or text in the same way as a mobile phone. It also has quick-launch keys, plus controls for multimedia use. No software or driver needed - just plug in the USB receiver. Requires 2 x AA batteries.

- Microsoft Windows XP MCE/ Vista compatible
- 2.4GHz
- 10m range
- 19mm optical trackball & mouse keys
- USB dongle receiver
- Dimensions: 180(L) x 50(W) x 30(H)mm

XC-4940 WAS $89.00

$69.00 SAVE $20.00

All-in-One Card Reader

As well as being able to read a multitude of formats, it has a flip top to store a number of micro, SD or XD cards. Has a two port USB 2.0 hub and storage for the USB cable.

- Ideal for roving photographers
- Dimensions: 87(L) x 39(W) x 18(H)mm

XC-4924

$29.95

Great Christmas Gifts for the computer addict

Limited stock on sale items.

All Savings are based on Original RRP

www.jaycar.com.au

Jaycar Electronics
Better, More Technical

Great Gift Ideas

3W CREE® LED Adjustable Head Torch

new

Three modes of operation - high, low and strobe.
The beam can be focused quickly from wide to spot by simply sliding the zoom in or out. Comfortable elasticised head strap.

- Output: 180/80 lumens
- Burn time: 8hrs
- Light modes: High, low, strobe
- Water resistant
- Requires 2 x AA batteries
- Weight: 105g with batteries

ST-3279

$39.95

3,000,000 Candlepower Rechargeable Halogen Spotlight

Provides 20 minutes continuous operation with 3,000,000 candlepower will be plenty of light for any outdoor activity. Ideal for rescue, shooting, fishing or boating. Rechargeable and ruggedly built.

- Built-in SLA battery
- Locking on/off switch
- High impact rubber lens protector
- LED map light
- AC and DC chargers
- Size: 210(L) x 150(Dia)mm

ST-3301

$29.95

Replacement globe SL-3221 $5.95

new

USB Combo Image Scanner with LCD

Convert your cherished old images to digital image format with this versatile and easy-to-use combo scanner. With USB connection, you can connect this to your PC and take high resolution scans of all your photos, slides and negatives to preserve in JPEG or TIF format. It also features a handy memory card slot and LCD so you have the option to preview and transfer all your scans directly to memory card without the need for PC connection.

- Crisp 2.4" LCD preview panel
- SD, XD, MMC, MS, MS-Pro memory card slot
- Windows XP and Vista compatible (32 or 64 bit)
- 3 x photo holders
- Dimensions: 210(L) x 230(W) x 150(H)mm

XC-4893 WAS $269.00

$229.00

SAVE $40.00

Mini 3 Channel IR Aluminium Helicopter

new

All aluminium airframe makes for a very robust mini chopper with 3 channels and a lot more control. 25 minute recharge gives about 10 minute flight time. It's very responsive and stable in flight.

- 3.7V Li-Po battery
- Remote requires 6 x AA batteries
- Size: 190(L)mm approx
- Suitable for ages 14+

GF-3310

$39.95

LCD Camera Alarm Clock

The camera can record still photos or digital video to a MicroSD card for playback on a PC. Recording is activated by the IR remote or automatically by motion or sound detection.

- 12 or 24 hour display
- Backlit LCD
- Recharges via USB
- Size: 110(W) x 60(H) x 35(D)mm

QC-8008

$129.00

new

90 Lumen CREE® LED Powered Torch

A high-powered aluminium moulded torch which is perfect for camping or around the house and garage. It features extremely high lumen output for its size and multiple light modes for emergencies or other situations. Fitted with a tactical switch to allow for a momentary on function. A solid and attractive design with the features to match. Carrying strap is included.

ST-3452

$24.95

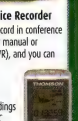
Voice Recorders

64MB Digital Voice Recorder

Record up to 26 hours of voice or notes in either dictation or conference mode, manual of VOX. Play back through the built-in 30mm speaker or use the included software. An LCD screen keeps track of everything and the simple intuitive layout as easy to use.

- Requires 2 x AA batteries
- USB cable and software included
- Variable speed playback
- Date and time-stamped recordings
- Dimensions: 97(L) x 45(W) x 18(H)mm

XC-0380 WAS $69.95



$49.95

SAVE $20.00

2GB 800 Hour Digital Voice Recorder

Never miss a quote again. Record in conference or dictation mode with either manual or automatic voice recording (AVR), and you can edit your recordings later.

- Records up to 800 hours in MP3 Format
- Date & time stamped recordings
- USB connectivity for easy PC connection (cable included)
- Variable Speed Playback
- Low battery indicator
- Requires 2 x AAA batteries
- Dimensions: 39(W) x 108(H) x 18(D)mm

XC-0382 WAS $129.00

$99.00

SAVE $30.00

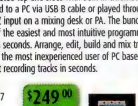
4GB Pen Video Camera

new

Maxwell Smart would have loved to have one of these to go with his shoe phone. Capture video, audio or still photos discreetly and quickly, then transfer them onto your PC via USB. The built-in memory stores up to 4GB, so there's plenty of capacity for taking electronic notes at your next meeting or protecting your legal rights by capturing a video or audio record of an event. It also functions as a conventional ballpoint pen.

- One-button operation
- Recharges via USB
- Drivers included
- Resolution: 640 x 480 VGA
- Still image resolution: 8MP
- Up to 2 hours of video or 600 photos
- Size: 148(L) x 15(Dia)mm

QC-8004



$99.00

Bluetooth Stereo Headset

Easily paired with any Bluetooth device such as a mobile phone or computer. Extremely light and comfortable. Microphone for Bluetooth hands-free capability and lithium ion rechargeable batteries which will provide hours of use. USB cable included.

AA-2067

$49.95

new

Gifts Over $100

Acoustic Guitar with Magix Music Maker Software & USB Connection

This is not just a guitar, it is a complete composition, arranging and recording package. Steel string acoustic guitar with laminated top and sides with built-in chromatic tuner and 3-band EQ. It can be directly interfaced to a PC via USB B cable or played through a high-2 output to an amplifier or to the high-2 input on a mixing desk or PA. The bundled recording software Magix Music Maker is one of the easiest and most intuitive programmes going around and will have you recording in seconds. Arrange, edit, build and mix tracks with intuitive, easy-to-use tools. Even the most inexperienced user of PC based recording will find it very easy to start recording tracks in seconds.

- No drivers required
- Compatible with Windows XP, Vista, 7
- Intuitive drag and drop software
- Chromatic tuner
- 3-band EQ ±12dB on each band
- Requires 1 x 9V battery
- Mac compatible

CS-2559

$249.00

Full Size Guitar

new

Digital Stereo Recorder - 2GB/50 Hours

Simple one button recording – press once for standby then again to record, or use the VOX function. It captures audio directly on built-in 2GB memory, which is ready for more than 50 hours stereo recording, or on high capacity SD/SDHC cards. Record at super-clean 24-bit resolution. Records via the stereo pair of microphones. You can also edit the recordings in the unit itself. Pocket size to take anywhere and can be powered by batteries or a 5VDC plugpack (not included).

- Formats: MP3, WAV
- Line in and mic inputs
- Headphone & built in speakers
- Sample rates: 16 - 96k, 16 or 24 bit
- Switchable stereo or mono
- Tripod mount
- Requires 2 x AA batteries (gives 15hrs)
- Dimensions: 60(W) x 112(H) x 22(D)mm

XC-0386

$199.00

Great Gift Ideas

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

Great Gifts for Kids

RC Ferraris

Superbly detailed and fully factory licensed, these RC Ferraris will give hours of fun for all ages. Pick from either 1:20 or the huge 1:10 scale 2008 F1 racer or GT California. They have 3 or 4 channels so you can race against each other, full function remote control and adjustable steering bias. Each has a rechargeable battery pack included for the car.

$69.95
SAVE $20.00

1:10 Scale RC Ferrari GT California
- 3-Channel
- Remote requires 1 x 9V battery

GF-3203 WAS $89.95

1:20 Scale RC Ferrari 2008 F1
- 3-Channel
- Remote requires 2 x AA batteries

GF-3207
WAS $54.95

$39.95
SAVE $15.00

1:20 Scale RC Ferrari GT California
- 4-Channel
- Working headlights
- Remote requires 1 x 9V battery

GF-3209 WAS $54.95
Limited Stock

$39.95
SAVE $15.00

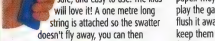
LED Sabre With Sound

Buy 2 for $30.00
SAVE $9.90

This unit sounds uncannily like the light sabre seen in the Star Wars® movies. They have the swooshing sound when held stationary and make that famous noise when they are waved around. They also change colours & glow quite brightly.

$19.95

- Extremely light and durable
- Size: 710(L) x 48(Dia)mm



*Star Wars® is a registered trademark of LucasFilm Ltd.

GF-3520

RC Wall Climbing Battle Cars

These clever little radio controlled cars can be driven vertically on walls and even upside down on ceilings. They come in a twin pack with two cars and two IR remote controls, to battle friends in a skillful bash barge game.

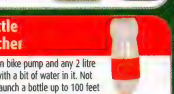
- Comes with 2 x climbing cars and 2 x 3 channel RC remotes
- Each remote requires 6 x AA batteries
- Cars 120mm long

GF-3285 WAS $79.95
Limited Stock

$29.95
SAVE $50.00

1:18 Scale RC Audi R8

This distinctive 27MHz RC super car replicas feature detailed bodywork, with all sporting see-through engine bays.



- Adjustable steering bias
- Built-in 500mAh battery recharges in 5-6 hours
- Remote requires 1 x 9V battery

GT-3696 WAS $59.95 Limited Stock

$49.95
SAVE $10.00

Aquapod Bottle Rocket Launcher

All you need is a common bike pump and any 2 litre plastic soft-drink bottle with a bit of water in it. Not only does the Aquapod launch a bottle up to 100 feet in the air, but it has a built-in safety valve that releases pressure at 60psi in order to keep everyone safe from over-pressurising the launcher. Built to last!

GF-3014 Selling fast!
Limited Stock

$34.95

Kitchen Scales

Kitchen scales, clock and weather station rolled into one. It weighs contents in metric or imperial measure up to 3kg (6.6lb), and doubles as a wall clock that displays temperature and humidity. Funky orange design. Requires 3 x AAA batteries.

- Kg or lb
- Size: 200(Dia) x 22(H)mm

XC-0161

$44.95

Great Gifts for

Rhinestone Desk Acce

What better way to jazz up her glittering rhinestone-finished de Available in pink and white.

Rhinestone Dual Power 8 Digit Calculator
- 8 digit LCD
- Battery included
- Measures: 145(L) x 100(W)mm

GH-1892 WAS $19.95
NOW $14.95 SAVE $5.00

Rhinestone Stapler
Takes 56 staples
Measures: 160(L) x 39(W)mm

GH-1894 WAS $19.95
NOW $14.95 SAVE $5.00

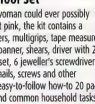
Rhinestone USB 4 Port Hub
- Lead 90(L)mm
- USB 2.0 compliant

GH-1898 WAS $29.95
NOW $24.95 SAVE $5.00
Limited Stock

FROM $14.95

23 Piece Mini Pink Tool Kit

Compact and easy to store, it comes in a trendy carry case and is perfect for doing repairs at home, around the office and for travellers. Good quality tools with rubberised grips to protect the most delicate hands! See online for full kit contents.



TD-2067

$19.95

149 Piece Pink Tool Set

Everything the handy woman could ever possibly need. Finished in bright pink, the kit contains a hammer, long nose pliers, multigrips, tape measure, screwdrivers, shifting spanner, shears, driver with 20 bits, 8-piece Allen key set, 6 jeweller's screwdrivers plus an assortment of nails, screws and other fasteners. Includes an easy-to-follow how-to 20 page booklet on each tool and common household tasks.

- Case measures: 250(W) x 322(H) x 65(D)mm

TD-2075

$49.95

Gifts under $15

The Amazing Flygun

It is a spring powered gun that kills flies and mosquitoes! It's fun, safe, and easy to use. The kids will love it! A one metre long string is attached so the swatter doesn't fly away, you can then reload, aim and fire again. It's fun and effective, and really does work!

- Suitable for ages 8+

YS-5545

$7.95

Sudoku Toilet Paper

Know a smart-alec? Give them a roll of this Sudoku toilet paper. They can play the game then flush it away! Sure to keep them amused for hours!

- Double ply for comfort

GH-1508

$5.95 Per roll

Keyring Keyfinder with LED Torch

This brilliant device will generate a beeping sound when it detects a whistle to enable finding those missing keys a breeze. Will work effectively within a 3 metre radius. Also doubles as a handy keyring torch.

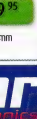
- Uses 2 x LR44 batteries (included)
- Size: 52(L) x 40(W) x 15(W)mm

XC-0351

$4.95

Personal Mini Alarm with LED Torch

A personal alarm made from tough ABS construction with a 120dB siren to deter thieves and attackers. To activate simply pull the rip-cord to pull out the pin. Replace the pin to deactivate the alarm. Also includes a LED light. Great for travellers.



- 105-120dB
- Includes 3 x LR44 batteries
- Dimensions: 72(L) x 31(W) x 22(H)mm

LA-5183

$9.95

Limited stock on sale items.
All Savings are based on Original RRP

Jaycar Electronics
Better. More Technical

ght & Sound

JV60 6.5" 3 Way Speaker Kit

new

JV60 6.5" 3 Way Speaker Kits - 150WRMS

With the return of the Vifa drivers, we are proud to re-introduce the JV60 speaker kit. By investing a couple of hours of your own time to build this superb system to compliment most mid-powered amplifier/receivers, you can save hundreds over commercial speakers. Kit is sold in two parts; speaker components with mounting accessories and pre-built speaker cabinets. Both have enough components to build a pair of JV60s.

JV60 Speaker Kit with Crossovers & Accessories - Pair

- Speaker kit includes woofers, tweeters, crossovers and mounting accessories.
- 4 x 6.5" Vifa P17WJ (see CW-2106 for specs), cast magnesium basket, mineral filled polycone woofer
- 2 x Vifa D25AG (see CT-2020 for specs), aluminium alloy diaphragm, Ferro fluid cooled tweeter
- 2 x 3-way, Linkwitz-Riley filter with polyswitch protection and impedance equalisation

CS-2560 $499.00 pair

Speaker Kits are Back!

JV60 Prebuilt Cabinets - Pair

- Bass reflex design with corner frequency of 35Hz
- Pre-built with all holes cut for components
- Finished in "blackwood" veneer
- 1090(H) x 250(W) x 260(D)mm (50L internal volume)

CS-2562 $199.00 pair

Pre-assembled JV60 Complete - Pair

We are also offering a fully assembled version if you just don't have the time but still want to experience the quality performance of this design.

CS-2564 $899.00 pair

Place your order in-store for a pre-built pair.

8 Way Speaker Selector

A perfect match for a multi-room sound system!

It's very easy to spread speakers all through your house and this speaker selector lets you simply and safely select which speakers you want on. The rear terminals are proper speaker spring terminals and includes an impedance matching network to keep a constant load on the amplifier.

- Power Handling: 100W RMS

AC-1682
WAS $199.00

$149.00
SAVE $50.00

5 Way Speaker Switch

A home entertainment switch box that allows up to five pairs of stereo speakers to be connected to a hi-fi system through a single stereo output terminal. Each pair of speakers may be individually turned on or off in any combination. Also features a separate headphone output socket.

- Add 5 sets of speakers

AC-1643

$39.95

Watch Cable TV All Over The House!

Beat the 2.4GHz congestion and enjoy the reliability and quality of this 5.8GHz transmitter and receiver. Provides hassle-free sharing of audio and video signals all over your house, office, factory or shop without the inconvenience and cost of running wires.

AR-1840

Additional receivers also available
AR-1841 $99.00

$148.00

Concord HDMI Leads

Feature heavily plated 24K gold plated connectors and oxygen-free heavy copper cabling. Each plug is solidly constructed for frequent, reliable use. Also featured are high quality moulded strain-relief cord grommets.

new

Male to male 500mm	WQ-7906	$34.95
Male to male 1.5m	WQ-7900	$39.95
Male to male 3.0m	WQ-7902	$49.95
Male to male 5.0m	WQ-7904	$59.95

HDMI Extender

The typical maximum range of a HDMI signal is just 12m at maximum - not very long if you are trying to send your high definition AV signal from one end of the lounge room to the other. This HDMI extender equalises and boosts your HDMI signal so that you can run cable up to 50m long.

- Supports up to 1080p resolution
- Compatible with VGA, SVGA, XGA, SXGA, UXGA
- Utomatic equalisation up to 1.6Gbps
- HDMI v1.3 compliant
- Dimensions: 68(L) x 40(W) x 18(H)mm

AC-1697 WAS $54.95

$24.95
SAVE $30.00

5.8GHz HDMI Sender with Remote Extender

Pipe HD TV to another room in your house. Simply connect the transmitter to the HDMI source and the receiver plugs into your HDMI equipped TV in the remote location. Such a handy device lets you enjoy the benefits of watching Pay TV in the bedroom in full-HD quality.

- HDCP 2.0 and CEC compliant
- HDMI 1.3 compliant
- Up to 1080p/60Hz video resolution (full HD)
- On-screen status display
- Dimensions: 180(L) x 140(W) x 39(H)mm

AR-1875

$499.00

new

TV Antennas

Digimatch VHF/UHF X-type Antenna

27 Element Digimatch VHF/UHF Antenna
(Not available in NZ)

Even if you've already got your digital ready TV, your antenna's reception may not be up to scratch. Quality made in Australia to suit our local broadcasts, this is an excellent top of the range antenna suitable for VHF, UHF digital and analogue TV. Superior carrier to noise ratio and Digital Matching System (DMS) for maximum performance - enjoy crystal clear reception of all your favourite shows as well as a host of new digital channels.

- Channels: 6-12 VHF, 21-69 UHF
- Gain: VHF 7dB, UHF 11dB
- Boom Length: 1320mm

LF-3195 $149.00

Also available:
32 Element (Not available in NZ)
LF-3175 $79.95

FROM $69.95

UHF Phased Array TV Antenna

Receives Bands 4 and 5 (channels 28-69)

This wideband antenna suits analogue or digital TV, and is ideal for fringe areas, where ghosting is a problem, or you aren't in direct line of sight of the transmitter. Ensure dad enjoys a clear signal. Excellent for NZ digital areas.

- Ideal for fringe areas where ghosting is a problem
- UHF channels: 21 to 69 (27 to 62 in NZ)
- Gain 11-13.5dB
- Dimensions: 610mm x 890mm

LF-3138 $69.95

LCD Computer Screen Desk Brackets

If your desk is clogged with notes, manila folders and finding space is becoming a dangerous balancing act, then you need an LCD bracket. These brackets use a C-type clamp for a powerful lock onto a variety of desk thicknesses. The monitor can be rotated 360 degrees horizontally and vertically and also extended to approximately 400mm from its base. Both brackets feature a sleek matte black finish for an inconspicuous blending into your desk motif.

new

Single Screen LCD Bracket
VESA mounting (75mm x 75mm and 100mm x 100mm)
Max load: 10kg monitor
Dimensions: 455(H) x 490(L)mm
CW-2831 $49.95

Double Screen LCD Bracket
VESA mounting (75mm x 75mm and 100mm x 100mm)
Max load: 10kg per monitor
Swivel: 360 degrees
Dimensions: 455(H) pole height, each arm 490(L)mm
CW-2833 $69.95

FROM $49.95

Home Theatre Powerboard

Surge protection and filtering is provided to all home theatre equipment connected to this powerboard as well as current protection via the in-built circuit breaker. Provides protection to telephone, data via a network connection, satellite/cable TV and TV aerials.

- 8 surge and spike protected outputs
- 10 amp resettable overload circuit breaker
- Protection neon indicators

MS-4024

$64.95

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Sight & Sound

Party Essentials

Lighting Effects

LED Strobe

This super bright LED strobe will add the necessary life to any party and produce an eye catching array of lighting effects to attract attention. They are equipped with a sound modulator to respond to sound or can be set to flash at a slow or fast rate.

- Adjustable brackets for optimal positioning

SL:2895

$45.00

DMX Lights & Controller

Team any of these LED DMX-controlled lights with a controller or software for complete control over your stage, party or DJ lighting setup. Each is 240V powered, individually addressable via DIP switch and includes a mounting bracket.

61 LED 4 Ch DMX Spotlight

- A budget lighting solution
- Robust ABS housing with 61 RGB LEDs
- Dimensions: 180(L) x 170(Dia)mm

SL:3420

$99.00

DMX Laser Show

Produces impressive lighting effects with sound activation or DMX master/slave control. Light weight and portable at only 1.5kg; take it with you to create a magnificent laser light atmosphere.

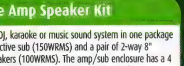
- More then 100 green patterns
- Sound activation microphone
- Safety function
- Dimensions: 205(L) x 80(W) x 145(H) mm

SL:3436

$199.00

19" Rack Mount DMX Controller

Control multiple DMX devices, such as lights, dimmers, fog machines or laser shows with pre-programmed scenes. Program multiple parameters like fade, pan, strobe, colour etc. limited only by the capabilities of the actual DMX devices being controlled, then save and play back each scene. Rack-mountable and mains powered. Visit our website for more information and programming tips.



- Control up to 12 devices
- 16 channels per device
- Dimensions: 482(W) x 133(H) x 70(D)mm

SL:3429 Limited Stock on all of the above!

$149.00

Active Amp Speaker Kit

A complete DJ, karaoke or music sound system in one package with a 12" active sub (150WRMS) and a pair of 2-way 8" satellite speakers (100WRMS). The amp/sub enclosure has a 4 channel mixer that takes inputs from any device that connects to line level RCA, XLR or 6.5mm inputs. Also record to a computer or digital multi-track recorder via the RCA line outputs. Two Speakon 4 metre cables are included. See instore or website for specifications.

- Dimensions: 410(W) x 520(H) x 460(D)mm

CS-2545 WAS $949.00

$899.00

SAVE $50.00

Professional VHF Wireless Microphone System

A professional wireless VHF microphone system with enhanced signal reception. Ideal for performers on the go, churches or halls etc. Includes 2 microphones, 1 wireless unit, and plugpack. Microphones require 2 x 9V batteries (not included).

- High-precision quartz crystal locked frequency
- Up to 80m range
- Dimension:195(L) x 145(W) x 42(H)mm

AM-4071

$99.00

3 Channel Microphone Mixer

Combines three microphone signals into one. Ideal for small PA applications or karaoke, etc. Each input has its own volume control. No power required.

- Weight: 205g

AM-4220

$29.95

12" Party Speaker

This speaker handles a massive 200WRMS @ 8 ohms and is an excellent addition to any entertainment equipment set up. Provides good performance in difficult locations such as backyards, tents, party rooms or halls etc.

- Size approx 620(H) x 400(W) x 330(D)mm.

CS-2514 WAS $249.00

$199.00

SAVE $50.00

Moondot Revolving Disco Light

Liven up any party with this funky light display. Featuring 18 bright red, green and blue LEDs that rotate, change colours and direction in response to the music being played.

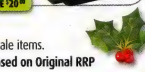
- 10m beam angle
- Auto mode (plug-play effect)
- Sound activated mode
- Mains powered
- Weighs 2kg
- Measures 200(L) x153(W) x 94(H)mm

SL:2898

$119.00

Mini Indoor/Outdoor Speakers

Made from ABS plastic and are weather-resistant, suitable for indoor or outdoor mounting. Brackets are supplied for mounting.



- Speakers: 4" Woofer and 2" tweeter
- 30WRMS
- Sold as a pair
- Cabinet size: 210(H) x 140(W) x 120(D)mm

CS-2430 WAS $79.95

Sold as a pair

$59.95

SAVE $20.00

Be Your Own DJ

2 Channel Pro DJ Mixer

Two channels each with RCA inputs for CD or other line level source and a set of dedicated phono inputs. The BPM counter is capable of accurately measuring the beats per minute of almost any kind of dance music automatically and works equally well with a CD player or a turntable.

- 2 band EQ on each channel
- Phono and line level inputs
- Selectable CF curve
- Dimensions: 330(W) x 22(H) x 102(D)mm

AM-4206

$149.00

i.Scratch CD & MP3 DJ Station

No need for a laptop or PC - the i.Scratch DJ Station gives you the digital DJ essentials. Front loading CD tray, large LCD screen and an XXL jog wheel. Sample banks, cue point banks, seamless loop & reloop, instant start, auto cue, fast cue, track & folder search, pitch range/bend and scratch. CD, CD-R, CD-RW, MP3 compatible.

- S/PDIF digital audio & RCA coaxial outputs
- Fully programmable repeat function
- Fader start & relay mode
- Measures: 348 (L) x 246(W) x 106(H)mm

AA-0493 WAS $349.00

$299.00

SAVE $50.00

Active PA Speakers with MP3 Controller

2-way active PA speakers that are powerful and extremely portable. Incorporates a 12" or 15" woofer and compression driver, 3 channels with balanced XLR inputs and unbalanced inputs, RCA line level inputs and an MP3 controller. Ideal for DJs, schools, sports, churches, weddings or conferences etc.

- SD card and USB inputs
- MP3 controller
- 2 band equaliser
- Line level RCA inputs

200W 12" Active PA Speaker with MP3 Controller

- Dimensions: 620(H) x 400(W) x 400(D)mm

CS-2529

$399.00

300W 15" Active PA Speaker with MP3 Controller

- Dimensions: 690(H) x 460(W) x 400(D)mm

CS-2530

$469.00

Solar Powered LED Ropelights

Put your Christmas lights anywhere without messy cables. The solar cell mounts to any flat surface and charges the built-in battery. When the sun goes down, your lights come on automatically and light the 100 red, amber and green LEDs with different selectable flashing patterns.

- Lights 10m long
- Solar panel: 148(W) x 105(H)mm

SL:2829

$49.95

Buy 2x SL:2829 for $69.90

SAVE $30.00

Party Essentials

www.jaycar.com.au

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Jaycar Electronics

Better, More Technical

Powertech Monocrystalline Solar Panels

As strong and tough as the better known brands, but at a more attractive price.

- Sizes range from 5 watts to a massive 175 watts
- For full technical spec ask in-store or visit online
- QC tested - all come with test certificate
- 25 year limited warranty

	CAT	NOW
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12V 10 Watt	ZM-9003	$89.95
12V 20 Watt	ZM-9094	$129.00
12V 40 Watt	ZM-9095	$249.00
12V 65 Watt	ZM-9096	$399.00
12V 80 Watt	ZM-9097	$449.00
12V 120 Watt	ZM-9098	$695.00
24V 175 Watt	ZM-9099	$949.00

5-in-1 Jump Starter-Inverter-Charger-Compressor-Work Light

Far more than your average jumpstarter this unit has an impressive set of features for a hundred different uses. Tucked in on either side are two tough insulated battery clamps for all your jumpstarting needs, on the front panel you have 2 x 12VDC cigarette lighter sockets for operating 12V appliances, a 5 LED worklight and two dial indicators for air pressure and charge status. Powered by the internal 12V 18Ah SLA battery, it even has a 400W inverter to charge your laptop, etc. See Website for specifications.

- Dimensions: 220(L) x 215(W) x 295(H)mm

MB-3594

Selling fast - stock limited

$149.00

Power up!

Full range of AAA & AA rechargeable batteries in store.

Fast Two Hour Battery Charger

Recharge up to four AA or AAA Ni-Cd or Ni-MH batteries with this handy charger that utilises Delta V voltage detection to ensure maximum battery life. Integrated LCD status display. Charge on the go with the car cigarette lighter cord included as well as the mains plugpack. Charge time varies to battery's capacity.

MB-3549

$29.95

240VAC Universal Ni-Cd & Ni-MH Battery Charger

An economical unit that can charge Ni-MH and Ni-Cd batteries. It has a discharge function for proper Ni-Cd battery cycling and a battery tester for 1.2 & 1.5 volt batteries.

- Includes battery tester for 1.2V to 1.5V cells
- Operates from 240V mains socket

MB-3505

$24.95

12VDC & 240VAC Smart Battery Charger

This microprocessor controlled charger will accept a combination up to 10 x AA or AAA cells and 2 x 9 Volt batteries. The integrated discharger can help minimise memory effects and negative Delta V sensing ensures maximum battery life. Includes charging timer. Individual LEDs show battery status.

- Mains power adaptor supplied
- Dimensions: 220(W) x 40(H) x 115(D)mm

MB-3551

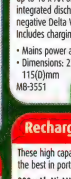
$59.95

Eclipse Alkaline Battery Packs

Alkaline AAA 12 Pk	SB-2334	$8.75
Alkaline AAA 24 Pk	SB-2331	$14.30
Alkaline AA 12 Pk	SB-2333	$8.75
Alkaline AA 24 Pk	SB-2329	$14.30
Alkaline AA 40 Pk	SB-2332	$21.95
Alkaline C 4 Pk	SB-2320	$7.70
Alkaline D 4 Pk	SB-2321	$9.00
Alkaline 9V 6 Pk	SB-2417	$15.25

SB-2332

SB-2334



DIN Rail Mounting AC and DC Circuit Breakers

new

Single AC circuit breakers for domestic and commercial switchboards, fuse boxes, distribution boards etc. Also 2-Pole DC breakers rated for 500VDC. Ideal for solar installations, marine or RV etc.

- Electrical safety authority approved

Single Pole AC 10A	SF-4150 $6.95
Single Pole AC 16A	SF-4151 $6.95
Single Pole AC 20A	SF-4152 $6.95
Single Pole AC 32A	SF-4153 $6.95
2-Pole DC 16A	SF-4155 $24.95
2-Pole DC 20A	SF-4156 $24.95

FROM **$6.95**

4-Way Lockable IP66 Circuit Breaker Enclosure

Designed to take the range of DIN rail circuit breakers. Standard 4-pole ABS enclosure, spring loaded clear front cover with padlock tabs, top, bottom and rear cable entry, DIN rail included, sealed to IP66. Suitable for electrical installations or solar applications.

- Dimensions: 96(W) x 195(H) x 98(D)mm

SF-4158

$34.95

new

Solar Chargers

Ideal for sealed lead-acid batteries, these chargers can be mounted on a flat surface or on their brackets so it can be moved to follow the sun. Great for use on a yacht, boat or in a car. Two models to choose from:

12 Volt 1.26 Watt Solar Battery Charger

- 12 Volt 1.26 Watt Solar Panel
- Voltage (max): 18V
- Panel Size: 159 x 175 x 17mm

ZM-9016 WAS $44.95
NOW $39.95 SAVE $5.00

12 Volt 4.5 Watt Solar Battery Charger

- Voltage (max): 18V
- Panel Size: 187 x 255 x 17mm

ZM-9018 WAS $99.95
NOW $89.95 SAVE $10.00

FROM **$39.95**

Rechargeable Batteries

These high capacity batteries provide the best in portable AA or AAA power.

900mAh Ni-MH AAA Batteries
Pk 4 SB-1739 $14.95

2,500mA Ni-MH AA Batteries
Pk 4 SB-1738 $23.95

2,000mAh Ni-MH AA Batteries
Pk 4 SB-1737 $17.95

Can Sized Inverter

Designed to fit neatly into a car's drink holder. This can sized inverter alleviates the need for permanent mounting and will run phone chargers, battery chargers, and laptop computers etc.

MI-5121

$49.95

Also available:
150W Inverter with USB Outlet

- Dimensions: 150(L) x 75(L) x 40(H)mm

MI-5125 $49.95

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Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. Prices valid to 23rd December 2010. All savings are based on original RRP

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Using the LM335Z for temperature measurement

This circuit was designed for use with a weather station that required a 0-0.7V signal for a temperature range of -7°C to +43°C. The temperature sensor chosen for the measurement was an LM335Z (TS1). This has an output of 0V at -273.15°C (absolute zero) and typically varies by 10mV/°C above absolute zero.

The change with temperature could be between 9.79mV/°C to 10.2mV/°C depending on the actual sensor. At 0°C, the sensor typically provides an output of 2.73V.

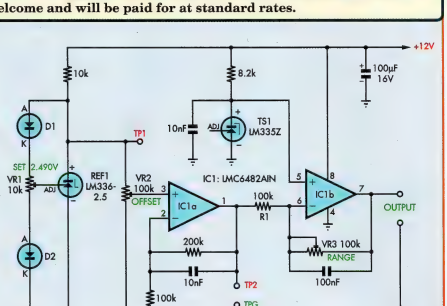
To use the LM335Z for the particular weather station, the signal needs to be level shifted and amplified so that the output voltage is 0V at -7°C.

The LM335Z is supplied with a nominal 1mA of current and a CMOS op amp (IC1b) monitors the voltage across it. VR3 sets the gain to about 1.4 to convert the nominal 10mV/°C from the sensor to 14mV/°C. This provides a 0.7V range in voltage for the 50°C temperature range from -7°C to +43°C

IC1a and the LM336-2.5 voltage reference (REF1) provide the offset adjustment for IC1b's output so that it is 0V at -7°C. REF1 has a nominal output of 2.490V and is temperature-compensated by two 1N4148 diodes connected in series with a 10kΩ trimpot (VR1). VR1 is adjusted to set the voltage across REF1 to 2.490V at 25°C.

Trimpot VR2 provides an adjustable reference to IC1a, ranging from 0V to 2.490V. IC1a amplifies this voltage by three and thereby provides an offset for IC1b.

For the weather station, IC1b's output needs to be 0V at -7°C. At -7°C, the LM335Z's voltage will be about (273 - 7) x 10mV or 2.66V. To reduce IC1b's output to 0V, we set IC1a's output to 6.65V to get the desired result.



Calibration of the unit is as follows:

(1) A multimeter is used to measure the TP1 to TP GND voltage and VR1 is adjusted for 2.49V at a temperature of about 25°C.

(2) VR2 is adjusted so that TP2 is at 0V.

(3) The LM335Z is immersed in a container full of stirred ice in distilled water, to provide a 0°C reference. VR3 is then set to give 3.822V at the output of IC1b. This is a setting of 14mV/°C at the output. Since the voltage is 0V at -273°C, the 0°C voltage will be 273 x 14mV or 3.822V.

(4) Finally, VR2 is readjusted so that the output is at 98mV. This is the 0°C reading, so the reading at -7°C will be 0V.

The circuit can be configured for a different temperature and output voltage range. For example, if the output is required to cover a 0-5V range for 0-100°C, then the gain of IC1b needs to be set to about 5. Resistor R1 should be changed to be 10kΩ. VR3 would then be set to about 40kΩ. At 0°C, the output from the LM335Z is about 2.73V and IC1b multiplies this by 5. To offset this voltage, IC1a's output would need to be (2.73V x 5)/4 or 3.41V.

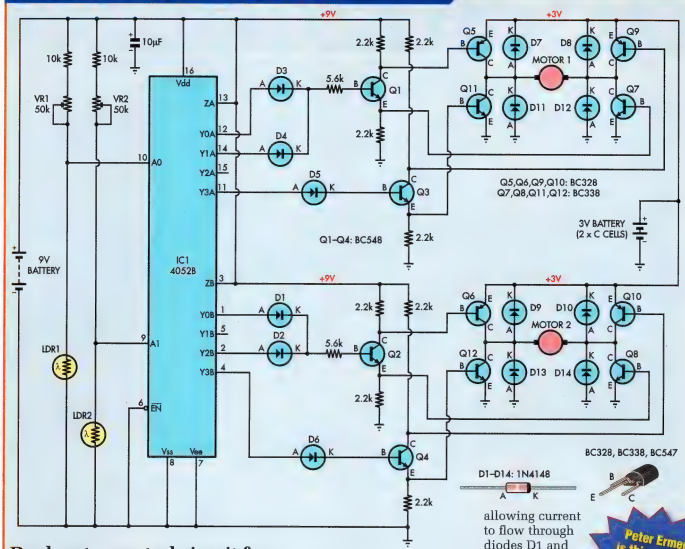
Calibration is the same for steps 1 & 2 above. Step 3 requires VR3 to be set so that IC1b's output is 2.73V x 5 = 13.65V. Step 4 adjusts VR2 for a reading of 0V at 0°C. Make sure VR2 is at the point where IC1b's output just reaches 0V. In other words, wind VR2 slowly and as soon as the reading at the output of IC1b drops to zero, stop winding VR2.

Winding VR2 further will prevent IC1b's output rising in level with temperatures just above 0°C.

Note that VR1, VR2 & VR3 should all be multi-turn trimpots to allow for accurate setting. Note also that the supply must be greater than 13.65V (but below 16V) to obtain the step 3 reading of 13.65V. After calibration, a 12V supply can be used.

Finally, the LM335 should be covered with a length of heatshrink tubing and sealed with neutral-cure silicone sealant.

John Clarke, Silicon Chip.



Dual motor control circuit for robotics applications

This circuit will drive two 3V motors for small robots, allowing the robot to negotiate an obstacle course. It has two H-drive (or "H-bridge") motor circuits, each employing four low-power BC328 and BC338 transistors. These are able to drive each motor forwards or backwards or stop it, independently. The driving transistors each have a diode connected between collector and emitter to provide protection against motor back-EMF spikes when the respective transistor is turned off.

Each H-drive circuit is controlled by a pair of NPN transistors, Q1 & Q3 and Q2 & Q4. Motor 1 drives the lefthand drive wheel (or track) while Motor 2 drives the right side. If both motors are driven at the same time, the robot moves forwards or backwards. If the left motor is driven while the right motor is stopped, the robot turns right and vice versa.

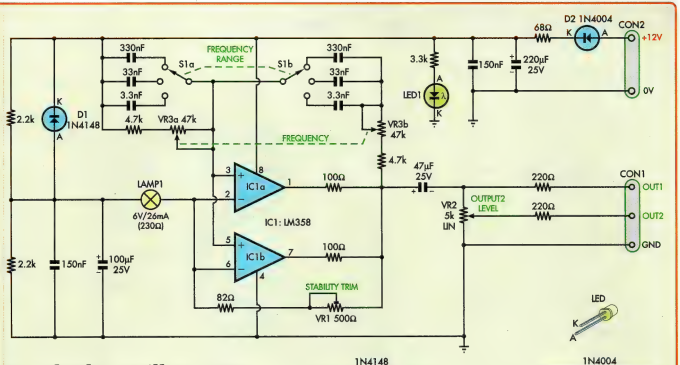
The motor control transistors (Q1-Q4) are driven by the outputs of IC1, a CMOS 4052 dual 4-channel multiplexer (or 1-of-4 switch), via diodes D1-D6. In turn, IC1 is controlled by a pair of light-dependent resistors (LDRs) mounted at the front of the robot. LDR1 is on the left while LDR2 is on the right. Other sensors can be used, such as microswitches with "feeler" wires or infrared photo-transistors.

Now consider what happens when light is falling on both sensors. Their resistances will be low, pulling IC1's A0 and A1 inputs towards 0V. In this case, IC1 connects outputs ZA to Y0A and ZB to Y0B, allowing current to flow through diodes D1 and D3. This then turns on Q1 & Q2, driving both motors and hence the robot forwards.

If the light level at LDR1 (at the left side of the robot) falls dramatically, IC1's A0 input goes high. In this case, ZA is connected to Y1A and ZB to Y1B. Q1 remains on, so Motor 1 continues to run forwards but current flow through D1 ceases and therefore Q2 turns off and Motor 2 stops. As a result, the robot turns to the right, away from the detected obstacle.

Alternatively, if the light level at LDR2 drops, the opposite occurs. ZA is connected to Y2A and ZB is connected to Y2B and in this case, D2 conducts and so Motor 2 runs forward but Motor 1 stops. The robot then turns to the left. If the light level at both sensors is low

Peter Ermen is this month's winner of a Peak Atlas Test Instrument



Wien bridge oscillator uses paralleled op amps

Typical Wien bridge oscillators produced in the past have used a negative temperature coefficient (NTC) thermistor in the negative feedback loop to provide envelope stabilisation, ie, to ensure a constant signal amplitude. However, suitable thermistors are not readily available so this design uses a much older method to provide envelope stability, by employing the non-linear resistance characteristic of a small incandescent lamp. This method works but it means that more power is required to drive the negative feedback loop.

This circuit solves that problem by connecting two identical operational amplifiers in parallel, so that their combined outputs drive the negative feedback loop which incorporates a 6V 26mA (230Ω) lamp. 100Ω resistors in series with each op amp output ensure that the load is equally shared. Note that other incandescent lamps can be made to work, such as 6V 40mA (150Ω), 5V 40mA (125Ω), 12V 40mA (300Ω) or similar. VR1 adjusts the circuit to provide a stable output voltage.

Three frequency ranges are selected with the double-pole switch S1. The ranges are 9Hz to 90Hz, 90Hz to 900Hz and 900Hz to 9kHz. Frequency variation within these ranges is provided by the 47kΩ dual potentiometer VR3. The output amplitude is varied using 5kΩ potentiometer VR2.

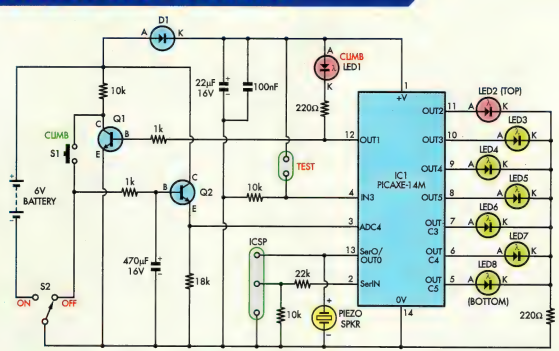
Note that the impedance of output OUT2 (and hence the output level) varies with the position of VR2. The level and impedance at OUT1 are fixed. General-purpose dual op amps such as the LM358 or TL072 may be used.

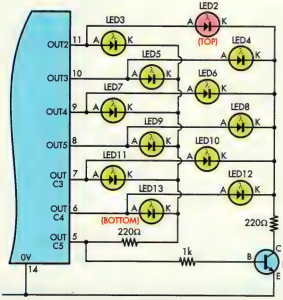
Petre Petrov,
Sofia, Bulgaria. ($60)

then ZA is connected to Y3A and ZB to Y3B, allowing current to flow through diodes D5 and D6. This in turn switches on transistors Q3 and Q4, running both motors in reverse and causing the robot to back away from the obstacle in front of it.

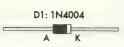
For the prototype, a dual-motor assembly with independent 4-speed gearbox was used (Jaycar YG-2741). The logic circuitry is powered from a standard 9V battery while the motors run off two regular cells (AA, C, etc).

Peter Ermen,
Burnett Heads, Qld.





12-LED DISPLAY OPTION (SEE TEXT)



LEDs & Ladders: the 2010 version

LEDs & Ladders first appeared in the March 1976 issue of "Electronics Australia" magazine. The game involves a man climbing out of a well using a ladder. He must climb only when the lights are on; if he climbs while it is dark he will fall.

This modern version of LEDs and Ladders uses a PICAXE14M microprocessor to replace the ICs used in the original game but retains the idea of a main capacitor that is slowly charged as you climb the ladder and quickly discharged should you fall. Playing difficulty is increased by the non-linear nature of the capacitor curve, by making climbing the ladder easier at the bottom and harder at the top. Also the charge can slowly drain from the capacitor – rest for too long and you may slip backwards.

Detailed playing instructions are included with the two programs. The game starts with the LED on the bottom rung of the ladder flashing. Press the pushbutton while the LED is on and you start climbing the ladder, press the pushbutton while the LED is off and you will quickly fall. When you eventually reach the top of the ladder, the Muppets tune will play to mark your lucky escape from the well.

The climb LED fitted next to the pushbutton makes it easier to time your button presses, and you may also bridge the test link pins to double the time the LEDs remain on, making climbing even easier.

The original game had a 16-LED display, while this PICAXE version has either a 7-LED or a 12-LED display. The number of LEDs used is not important, since it is the 470µF capacitor circuit that determines the total button presses required to climb or fall, so by fitting fewer LEDs you simply press the pushbutton more times for each step.

The PICAXE14 M microprocessor has six inputs and six outputs but this program converts three of the

Lightning detector uses 555 timer

Most people are aware that lightning causes interference to radio reception and that it causes bursts of noise, particularly on an AM broadcast band radio. The radio spectrum radiated from a lightning burst peaks at about 5kHz and extends above 10MHz. Typical lightning detector circuits may be tuned to frequencies below the broadcast band.

The circuit presented here is based on a general-purpose NPN transistor which amplifies the noise picked up by an antenna. Large impulse noise bursts will tend to drive the transistor into saturation, pulling its collector down to 0V.

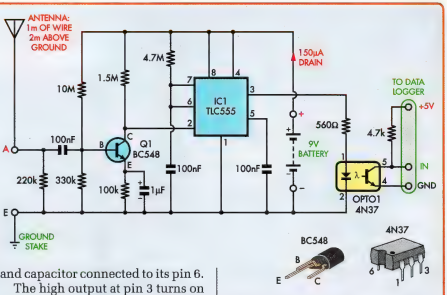
Each time this happens, it triggers a 555 timer which is configured as a monostable. When triggered, its output at pin 3 goes high for a period determined by the resistor and capacitor connected to its pin 6.

The high output at pin 3 turns on the LED inside optocoupler OPTO1 and so the output at pin 5 is pulled low. This may be used to drive a data logger.

Alternatively, the 555 could drive a LED and piezo buzzer to give a warning of an approaching storm.

The circuit should respond to a fluorescent lamp being turned on within a range of about two metres.

Carl Morey,
Gin Gin, Qld. ($40)



inputs into outputs using "PORTC" commands, to give a total of three inputs and nine outputs. The main circuit diagram shows both a 7-LED display (which would be selected mainly for ease of construction) and an optional 12-LED display. The latter makes play more exciting, as you can move up and down more quickly.

Within the programs, the 12-LED display has 12 equal analog-to-digital converter steps driving the LEDs, while the 7-LED display has seven unequal ADC steps, with larger steps at the bottom and smaller steps at the top. The memory available allows only the 7-LED program to include a soft reset using pushbutton switch S1 rather than the hard power switch reset (S2).

The main capacitor circuit runs from the 6V battery while a diode reduces the PICAXE supply voltage to 5.3V. This offsets the voltage dropped across emitter-follower Q2, increasing the voltage swing on the A/D converter input (pin 3). The climb pushbutton needs to be a tactile or snap action type to make the game reliable.

Finally, the main capacitor is discharged by placing the power switch in the "off" position, forcing a reset.

Ian Robertson,
Engadine, NSW. ($70)

Note: the software, ladders7.bas and ladders12.bas can be downloaded from the SILICON CHIP website.

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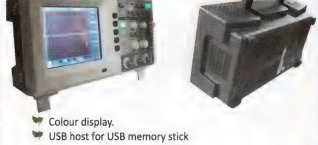

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Tektronix enhances their 'World's Most Popular Oscilloscope' series

Tektronix claim their new TDS2000C Series 'scopes provide even more features and performance and include a new 50MHz entry-level model with a starting price below $1000. This represents a 25% reduction from the previous lowest priced model and is lower than similar models from other brand-name suppliers. Models range from 50 MHz to 200MHz bandwidth and with two or four channels.

A number of the existing models now offer increased performance, such as two models that were 60MHz bandwidth are now 70MHz and two models that offered 1GS/s sampling rates and are now at 2GS/s. All include easy connectivity with USB ports, an expanded set of 16 automated measurements, a new limit test feature, intuitive operation with built-in help menus, and the industry's only lifetime warranty.

Every model features digital real-time sampling with at least 10X oversampling on every channel. The sample rate doesn't reduce as additional channels are turned on, ensuring that each channel can accurately capture signals up to the oscilloscope's full bandwidth.

A simple user interface includes features such as the autoset menu, built-in help system, probe check wizard, and optimized instrument setup and operation. Special features include advanced triggering to quickly capture events coupled with advanced math capabilities and now 16 automated measurements for fast analysis.

New capabilities include datalogging and limit testing. After a user has configured trigger conditions, datalogging makes it possible for the oscilloscope to save all the triggered waveforms together with time stamp information to a USB flash drive within a user-defined duration (up to 8 hours). The limit test function can be used to quickly identify problems and alert a production line operator when an input signal falls outside of a predefined mask. Without this function, operators would need to watch carefully and manually compare measurement data with printed criteria.

Available through authorized distributors or directly from the Tektronix online store, all models of the TDS2000C Series oscilloscopes are available now. They include the Limited Tektronix Edition of National Instruments' SignalExpress software.

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Nook-and-cranny spy camera with colour screen

How many times have you needed to peer into an impossible-to-reach place, such as a wall cavity, inside equipment, machinery and so on?

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First, there's a tiny colour camera mounted on the end of a 1m flexi-shaft. The camera is equipped with two bright white LEDs so you can view in complete darkness.

This shaft connects to an easy-to-hold handle which also contains a 60mm (2.4-inch) hi-res colour monitor. There's an on/off switch with brightness control mounted right on the handle as well. It's all powered by a standard 9V battery which also fits inside the handle.

Along with the handy protective carry case, the Video Scope also comes with a mirror which can mount on the end of the camera (great for looking back towards you) and a magnetic hook which can capture objects, wiring, etc that the camera detects.

We've seen a few of this type of Video Scope over the years but this one is one of the handiest.

It has a recommended retail price of $249 inc GST and is available from all Machineryhouse branches.

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LinkZero-AX: a new chip for zero power waste

The LinkZero-AX chip effectively turns off the auxiliary power supply when the end product is idle. Power-down mode is triggered by a signal accessible to a microcontroller, completely shutting down switch-mode operation and internal switch control circuits, eliminating energy wasted by these unnecessary functions. While in power-down mode, the LinkZero-AX stays alive, allowing the IC to be awakened with a reset pulse or button press.

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3-in-1 (DAB+, HD Digital TV & Stereo FM) USB PC Tuner from Oatley Electronics

There's a lot of USB TV tuners about, especially on the 'net but this is the first one we've seen that will also handle DAB+ radio as well as FM stereo.

The PCTV Nano from Oatley Electronics plugs into any computer USB port and a suitable antenna (rabbit ears in many locations!) and then you can not only view HD TV on your PC but record, time shift and all those other things that the PC gives you control over.

But it's the DAB+ radio capability that really makes this little beauty stand out. With full menu control via the supplied software on CD, you're ready to start experiencing digital radio without forking out big bucks for a DAB+ tuner.

In fact, the introductory price for the PCTV Nano is just $34.90 – that's a lot cheaper than the majority of those questionable performance DAB+ radios on the market!

The PCTV Nano comes complete with a TV antenna socket adaptor (ready to plug straight in), the software CD mentioned above and an infrared remote control which gives you total control over the unit – arguably much more than you would get with most DAB+ tuner remotes!

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Class-D chip has noise mitigation

Silicon Labs have recently released their Si2704/5/6/7 series, a 2.1 x 5 W EMI mitigating class-D audio amplifiers. They combine class-D efficiency and digital signal processing to solve the difficult class-D amplifier radiated noise problems plaguing EMI compliance, AM/FM radio co-existence and smart phone/iPhone compatibility.

The key markets include stereo systems such as smart phone/iPhone docking stations, table top radios, boom boxes and radios powered by four or more batteries. The stringent over-the-air (OTA) radio interference testing by Apple makes the Si2704/5/6/7 all-digital architecture, EMI mitigation and feedback particularly useful to the user. All radio applications benefit from EMI mitigation and AM radio products will especially benefit from the tunable noise-free notch within the AM radio band.

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How to use the software. . .

DIGITAL LIGHTING CONTROLLER

Part 3 – by Nicholas Vinen

Christmas is just about here! Have you got your Digital Lighting Controller ready yet? In the first two articles we explained how the Digital Lighting Controller works and how to build it. This third article explains how to use the software – primarily the Windows-based sequencing program.

As it turns out, the majority of the time spent developing this project involved writing software – both the firmware and the sequencing utility. We only had space for a quick rundown of the software functions last month. Here is a more detailed explanation.

Audio conversion

As previously stated, the Digital Lighting Controller supports audio files in the WAV format, with 16 bits per sample, mono or stereo, in one of the supported sample rates (11.025kHz, 12kHz, 22.05kHz, 24kHz, 32kHz, 44.1kHz or 48kHz).

If you have an MP3 file (or other format) that you want to play or sequence using this device, you can use third party software to convert it to WAV. This is also necessary if you want to use a WAV which contains compressed data (eg, µLaw or aLaw). There are many pieces of software capable of doing so.

The best is probably Audacity (http://audacity.sourceforge.net/). It is available for Windows, Mac OS X and Linux/Unix and can be downloaded and used at no charge. All you need to do is open the audio file and then use the File->Export command to save it as a WAV.

This WAV file can then be loaded into the sequencing software. Note that it only handles simple WAV files (one chunk, etc). This is because it uses the same WAV routines as the master unit does, so if you can open the file in the Windows software then it should work on the master unit too. Even so, it doesn't hurt to check that the master unit will play the WAV before you begin sequencing it.

Operation and additional features

Sequences can be created with or without audio. Sequences with audio have a .lsq file extension, those without have a .lsn extension.

The master unit scans the memory card for any files with a .wav or .lsn extension. WAV files are played with or without an accompanying .lsq lighting sequence. If there is no sequence, the lights are all switched off as the audio plays.

If an .lsn file is encountered instead, the audio output plays silence while the lighting sequence is displayed. In either case, after the sequence is finished, it moves onto the next file (unless you use the single file playback buttons on the remote control).

Since the last article was published, we added a "mute" command which can be triggered from either compatible remote control. It immediately sets the audio volume to zero and is cancelled by pressing mute again, changing the volume or else pressing play. It can be re-mapped to other infrared codes like the other remote control commands.

Note that a sample configuration file, showing all the main options, will be included with the HEX file and source code downloads.

Limitations

Because the sequences are stored compressed (reducing

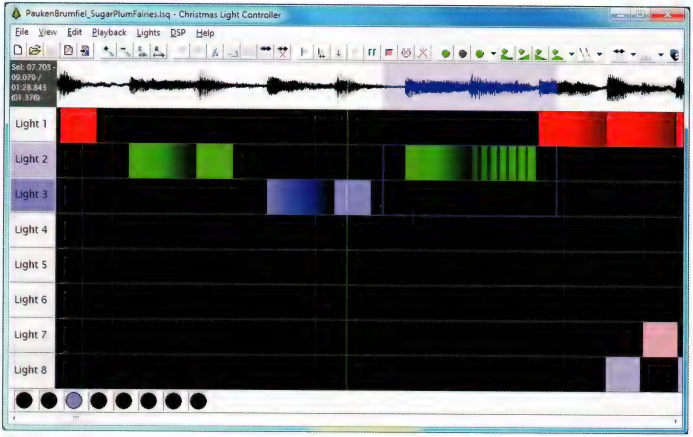

Fig.1: the main window, showing the WAV audio data at the top and the sequence below. The blue rectangle shows the current selection while the green line is the playback cursor. The simulated light state is shown at the bottom. The main sequence display, in the middle, represents the brightness of each light over time with strips of colour. Note that some of the toolbar buttons are disabled. If you move the mouse cursor over them, you'll find out why.

file size and memory card I/O), there is one minor restriction. Light ramps (when the brightness slowly fades up or down over time) have a minimum and maximum time period.

The possible range is about 0.016 to 8.2 seconds. It's unlikely you will need to go outside this range and if you do, the software will automatically adapt. For long ramps, it will substitute a series of evenly spaced "set brightness" commands to give a similar effect. Still, it is a good idea to avoid very short or long ramps since they can complicate further sequence manipulation.

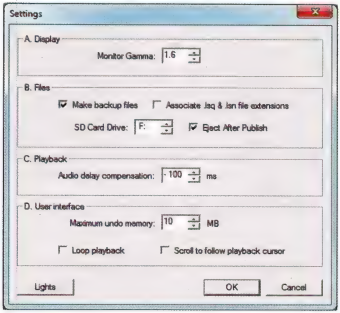

Fig.2: the settings dialog which provides a few options for tweaking the behaviour of the program. Most of the settings only need to be changed once.

Sequencing software

To install the Windows sequencing software, simply

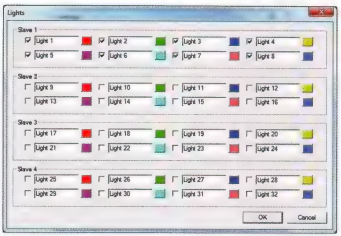

Fig.3: the lights dialog, accessible via settings, which allows you to name each light channel and select the colour in which it will be displayed.

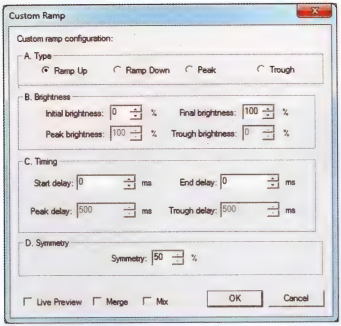

Fig.4: the Custom Ramp dialog allows you to create light ramps with a specific profile. Once a profile has been set up, it can be repeated many times on different channels at different times.

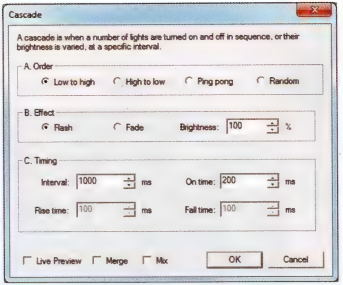

Fig.5: with the Cascade dialog you can create a pattern of lights across multiple channels. The lights flash in the specified pattern at the selected interval.

download and run the executable file. It will ask you a few questions (such as where to put the files) but most users can ignore the questions (leaving the options at their defaults) and just click the "Next" button until the installation is complete.

The first time you run the sequencing software, it is a good idea to go to the Settings screen (Edit→Settings) and adjust the options.

The most important is the audio delay. To set it, select a WAV file which has an obvious beat and then create a new sequence for it. Use the Play command (on the toolbar or in the menu) to play the file and watch the playback cursor (a green vertical line) as it moves across the display.

The beats should be visible as spikes in the WAV display at the top of the window. As the playback cursor reaches each spike, you should hear the beat simultaneously. If the playback cursor reaches the spike before the beat sounds, increase the delay. If the beat sounds before the playback cursor reaches the spike, decrease it. The possible range is ±1000ms (±one second). Repeat until it is correct.

The rest of the settings are explained in Table 1 at right. Having set them to your satisfaction, you are ready to create sequences. The rest of this article is dedicated to explaining the various controls, commands and options which you can use in choreographing your light display to the music.

Mouse controls

The mouse wheel zooms in or out on the sequence, centred on the portion under the mouse cursor. Rolling it up zooms in while rolling it down zooms out. Note that this is true even while you are dragging a selection (see below).

Right clicking in the WAV display (at the top) or sequence display (below it) re-centers the display on that location. Right-dragging (ie, right-clicking and holding) in either area pans the display left or right. Panning can also be accomplished using the scroll bar, at the bottom of the window.

Table 1 – Settings

Monitor Gamma	Used to display light brightness accurately. The default is 1.6, common values are 1.6 – 2.2.
Make backup files	If on (the default), each time you save over a sequence, the old file is kept with a different extension (maximum of ten backups).
Associate file extensions	If on (defaults to off), sequence files can be opened by double-clicking them in Windows Explorer.
SD Card Drive	This is auto-detected but may need to be changed. The "Publish" command copies the sequence to this drive.
Eject After Publish	If on (the default), after publishing a sequence, the memory card is "ejected" so that it can be immediately removed.
Audio delay compensation	Some sound drivers do not accurately report the playback position. If the audio synchronisation is off, adjust this value.
Maximum undo memory	Undo records are kept forever until they use up more than this much memory, when the oldest undo records are discarded.
Loop playback	Can also be set on the toolbar. If on, when playback reaches the end of the selected section, it starts again from the beginning.
Scroll to follow playback cursor	Can also be set on the toolbar. If on, when the playback cursor approaches the edge of the window, the display scrolls to follow it.
Lights	Selects which light channels are available and sets the associated names and colours. By default, the first eight are enabled.

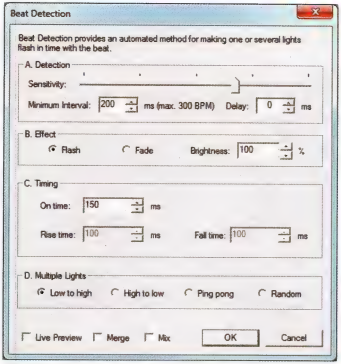

Fig.6: Beat Detection provides an automated hueristic for detecting beats in the music and causing lights to flash in time with them. It operates similarly to Cascade but the flash times are determined by the music, rather than a simple interval.

The mouse is used to define the selection initially and can also be used to adjust it. The selection is a portion of the sequence, outlined in blue. Most commands which manipulate the sequence only change the portion within the selection.

To make a selection, move the mouse into either the WAV display or sequence display and hold the left button down. You can then "drag out" an area to select it.

If you click the button rather than dragging the mouse then this will select a single time point in the sequence. In this case, the "Play Selection" command will play from that point until the end of the sequence and the "Paste" command will paste the copied data beginning at that point.

When dragging a selection, you can also move the mouse vertically to select one or more light channels simultaneously.

Once a selection has been made, you can drag the edges, changing the time span or the range of light channels selected. A double-arrow cursor indicates when the mouse is in the right location to change the selection.

While using the mouse to create or adjust a selection,

Table 2 – Custom Ramp options

Type	Ramp Up increases brightness over time, Ramp down decreases it. Peak ramps up and then down while Trough ramps down and then up.
Brightness	Defines the brightness at the salient points for the given ramp type.
Timing	Normally the ramp is stretched to fill the selection. Start and End Delay allow for padding. Peak/Trough delay, if set, create a brightness plateau in those modes.
Symmetry	Available in Peak and Trough modes. The up and down ramps take the same time with 50% symmetry while other values emphasise one or the other.

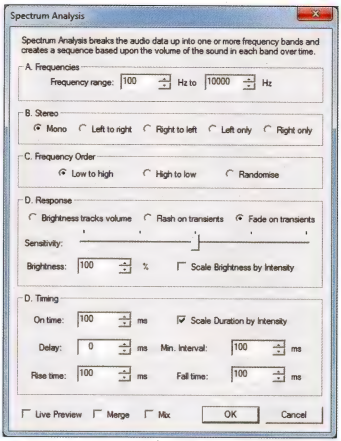

Fig.7: Spectrum Analysis operates like Beat Detection but it breaks the audio up into multiple frequency bands and controls each lighting channel based on the audio within the separate bands.

Table 3 – Cascade options

Order	The order in which channels are flashed. "Low to high" starts with the first selected channel and then moves to higher channels, wrapping back around to the first. "High to Low" is the opposite. "Ping pong" alternates between the previous two. "Random" creates an arbitrary pattern.
Effect	When Flash is selected the light simply turns on for the selected On Time. With fade, the beginning and end are ramped, according to the Rise time and Fall time settings.
Brightness	The peak brightness of each light flash.
Interval	The time between flashes being triggered on subsequent channels. This can be shorter than the On time if desired and the flashes will overlap.

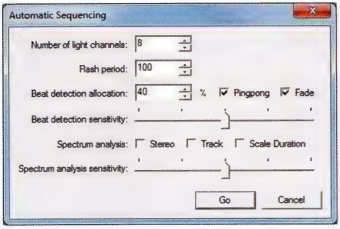

Fig.8: Automatic Sequencing is a feature which allows you to quickly and easily generate a sequence for a piece of music, based on beat detection and spectrum analysis. It can be further modified or used as-is.

if you move the mouse cursor off the left or right edge of the sequence area, the display will automatically scroll in that direction.

The light channel selection can be altered without affecting the selection time span by clicking on the light names at the left side of the window. Holding down shift or control while clicking on the light names allows you to select a range or group of them. This allows you to manipulate a number of channels at once, eg, to create a Cascade (more on this later).

It is also possible to adjust the amount of space available for WAV data display at the top of the screen. Move the mouse over the line dividing the WAV and sequence area and drag it up or down. You can use the same technique to adjust the left/right split between the light names and the sequence data.

Keyboard controls

In addition to the keyboard shortcuts (shown in the menus), there are some extra keyboard controls which perform basic functions such as changing the selection.

The arrow keys, in combination with shift and control, allow you to move the current selection or scroll the display. The left and right arrows by themselves move the selection left and right and if shift is held down at the same time, it moves in larger increments (x10). Moving the selection with the keyboard allows you easily make fine timing adjustments.

Table 4 – Beat Detection options

Sensitivity	Determines the transient energy required to trigger a light flash.
Minimum interval	Once a beat has been detected, any transients are ignored for this period after it. The equivalent maximum BPM (Beats Per Minute) are shown.
Delay	Each light flash is offset by this amount (±) from the detected transient. Most commonly used in "Fade" mode to compensate for the initial ramp.
Effect, Timing, Multiple Lights	As with Cascade. The "Multiple Lights" settings are only available if more than one light channel has been selected.

The up and down arrows also move the selection up and down, selecting a different set of light channels. If shift is held down at the same time then rather than moving the selection, it is extended.

If the Control key is held down while pressing the left and right arrows, the display scrolls left or right. In this mode the shift key can also be used for larger increments.

Dialogs

While much of the sequencing work is done in the main program window, the software also includes a number of "dialogs". These are windows which pop up when certain options are selected, allowing you to enter additional parameters.

The available dialogs are: Settings, Lights, Custom Ramp, Cascade, Beat Detection, Spectrum Analysis and Automatic Sequencing.

The first two are used to alter the behaviour of the program while the others manipulate the sequence in some way. One thing they all have in common are the "OK" and "Cancel" buttons. Either button will close the dialog, but pressing "Cancel" also discards any changes made since it was opened.

You can only have one dialog open at any time. For dialogs that manipulate the sequence, only the selected portion is affected, except in the case of Automatic Sequencing which always operates on the whole file. Thus, most of these dialogs are unavailable while there is no selection.

Previews

Some options are common to several dialogs. If "Live Preview" is turned on then the selected operation is performed immediately so that you can see what its result will be. If you then cancel the dialog, the changes are undone.

Table 5 – Spectrum Analysis options

Frequency range	The upper and lower ends of the frequency bands. This range is broken into enough logarithmic steps for the selected light channels.
Stereo	If "Left to right" or "Right to left" are selected then the light channels are divided in half, one set using left channel audio and the other right channel audio. Otherwise, the selected channel is used for all bands.
Frequency order	Determines the order in which the resulting bands are mapped onto the light channels.
Response	The Flash and Fade modes work similarly to Cascade. The Sensitivity control works similarly to Beat Detection. For "Brightness tracks volume", instead of flashing, the brightness of each light channel varies continuously, tracking the audio level in each frequency band.
Scale brightness by intensity	In Flash/Fade mode, this causes the brightness to be modulated by the intensity of each transient.
Scale duration by intensity	In Flash/Fade mode, this causes the On Time and if appropriate, Rise and Fall times, to be modulated by the intensity of each transient.
Timing	As for Beat Detection.

COMMANDS

The software supports many commands which are accessible via the menu or the toolbar. While most of them are self-explanatory, the following are worth elaborating.

File->Publish Sequence	This copies the loaded sequence onto your memory card along with the accompanying WAV file (if appropriate). The memory card drive letter is set automatically but you should check the Settings before using this feature and adjust it if necessary.
Edit->Paste Special	Normally when you copy and then paste sequence data, the data is copied exactly. The only change normally made is when the selection into which it is being pasted is smaller than what was copied, in which case some of the data is omitted. However, the Paste Special menu provides five ways to paste data that also manipulate it in some way. If Paste Stretch is used, the duration of the data copied will be lengthened or shortened to fit the current selection, time-stretching it. Paste Mix and Paste Merge allow the sequence data in the copy buffer to be combined with the data within the current selection. In the case of "Merge", the brightest light value will dominate at any given time. This is useful in a case where you want to leave the existing sequence as it is but add new lighting commands on top. "Mix" is similar but the resulting brightness is the product of the existing and pasted brightnesses. This is especially useful with the Custom Ramp option as it allows you to take a series of light flashes (or ramps, etc) and apply a ramp over the top which modulates their brightness over time. This effect is shown within the selection in Fig.1.
Edit->Copy Buffer Storage	Normally, if you perform a "Cut" or "Copy" command, the contents of the copy buffer are replaced with the selected data and thus lost. Sometimes you need to be able to store multiple sequence sections in order to paste them later, in a different order. Copy Buffer Storage gives you nine additional holding locations. First, copy or cut the data in the normal manner, then store the contents of the copy buffer using this menu. The contents can be retrieved later and then pasted as usual.
Edit->Selection Storage	This menu allows you to store the location of the current selection so that you can recall it later. After making a selection, store it in one of the nine locations. It can then be restored any time. The stored selection includes both the light channels and time span.
Edit->Change Length	This is only available if you are editing a stand-alone sequence (ie, one without audio). In this case you can change the length (ie, running time) at will. Note that if you reduce the length, any data past the end will be lost.
Playback->Set Playback Region	If you select a time span and then use this command, the selection becomes the new playback region, which is shown in red. It is then independent of the selection. The "Play Region" command will then play that portion of the sequence. This is handy when you want to make a number of changes to a given section and play it back to check what you have done afterwards, without having to re-select the whole section each time.
Lights->Cancel Light Actions	All sequence commands in the selection are deleted. This means that during this period, the lights will remain in whatever state they were left just prior to it. To turn the lights off instead, use the "Lights Off" command.
Lights->Set Light Brightness	This option sets the brightness of the selected lights, in the selected time period, to be a constant, between 0% and 100% of full brightness. The actual brightness is set using the dropdown arrow adjacent to this command in the toolbar.
Lights->Interpolated Ramp	This ramps the brightness of the selected lights smoothly from whatever brightness they are at the beginning of the selection to that at the end.
Lights->Ramp Up/Down	These commands take the brightness of the selected lights at the beginning of the selection and either ramps them up to maximum brightness or down to minimum brightness (off) over the selected period.
Lights->Custom Ramp/Cascade	See the section on Dialogs.
DSP->Beat Detection/Spectrum Analysis/Automatic Sequencing	See the section on Dialogs.

Table 6 – Automatic Sequencing options	
Number of light channels	Defaults to the number of available channels. Use a lower number to leave some channels unaffected.
Flash period	Controls the flash duration
Beat detection allocation	The proportion of available channels to dedicate to the Beat Detection function.
Pingpong	Controls whether the Beat Detection uses "Low to high" or "Ping pong" order.
Fade	Controls whether the Beat Detection uses "Flash" or "Fade" mode.
Beat detection sensitivity	Allows the sensitivity to be adjusted over the most useful portion of the range.
Spectrum analysis	Stereo controls whether the Spectrum Analysis feature uses "Left to right" or "Mono" mode. Track selects either "Brightness tracks volume" or "Fade" mode. "Scale Duration" selects either "Scale Brightness" or "Scale Duration" mode.
Spectrum analysis sensitivity	Allows the sensitivity to be adjusted over the most useful portion of the range.

If you adjust any of the dialog parameters, the preview will update to reflect the change.

Because the operation could be slow if the selection is large (eg, Spectrum Analysis), it is a good idea to zoom into a portion of the selection while using Live Preview. In this case, only the visible portion will be updated, speeding up the preview.

Once you click "OK" then the operation will be performed over the entire selection.

Any operations which take more than about a quarter of a second will display a progress dialog. This is true whether it is a preview or the final operation which is being performed. When the progress dialog is open, it is possible to cancel the operation.

Note that it is possible to go to the main window and scroll/zoom while a dialog is open. If Live Preview is active, the preview will automatically re-calculate when the view is changed (if necessary). You can also change the selection while a dialog is open. If Live Preview is active then the preview will be changed to apply to the new selection.

Common options

The other two common dialog options are "Merge" and "Mix", which perform the same operations as described under the "Paste Special" command.

When you click "OK" in a dialog, the options that you have selected are remembered for next time you perform that same operation.

In addition, many of the dialogs are accessible via the toolbar as double-action buttons. Clicking the dropdown arrow alongside the button opens the dialog while pressing the button itself immediately applies the associated operation.

This means that once you have the options set up the way you want and clicked "OK", you can repeat the same operation on a different selection using the toolbar button, without having to go through the dialog.

Alternatively, you can click the dropdown arrow and adjust the parameters again.

Custom Ramp and Cascade

The Custom Ramp dialog allows you to create a smoothly changing brightness level for one or more lights over a given time period. See Table 2 for the possible options.

Note that as you change between the four different ramp types, the brightness values are shuffled around so that you don't have to make as many adjustments.

Cascade creates an effect where flashes occur across multiple light channels over time, with a constant period and duration for each flash. It is also possible to smooth the beginning and end of each flash with a brightness ramp.

See Table 3 for the available options. It is possible to select a single light channel for a Cascade, in which case the Order option is disabled since it has no effect.

Beat Detection

Beat Detection provides a means to analyse the audio and attempt to discover the beat by looking for transients. Before searching for transients, a fourth-order notch filter is applied to the audio (400Hz-4kHz) in order to eliminate vocals and other instruments which might otherwise fool the algorithm.

The sensitivity is critical and its operation is not always intuitive. It is a good idea to pick a small section of the audio file and try different sensitivity settings (using the Live Preview option) in order to detemine the setting which picks up the beats most reliably without much spurious triggering.

The best settings are usually between mid-scale and halfway to maximum.

Once the beats are detected, they are passed onto the Cascade routine, providing similar options for light triggering on each detected transient. The full set of options are explained in Table 4.

Spectrum Analysis

This is the most complicated of the sequencing dialogs. Spectrum Analysis is much like Beat Detection but rather than using a notch filter, instead the frequency spectrum is broken up into a series of bands and a bandpass filter (fourth order) is applied to isolate each set of frequencies. As with Beat Detection, transients in the result trigger flashing lights.

Because each lighting channel operates on a separate band, that means that the lights respond to different frequencies, creating a more interesting effect. See Table 5 for a summary of the options.

The final dialog, Automatic Sequencing, combines Beat Detection and Spectrum Analysis while presenting fewer options.

This makes it easy to create a quick sequence for an audio file. Simply click the icon, adjust the settings (or leave them at the defaults) and then click "Go".

There is no preview in this mode but if you do not like the results you can undo the changes, adjust the parameters and try again.

For a description of the Automatic Sequencing options, see Table 6.

Connecting multiple lights without spending big $$$!

As you will recall from the first two parts, the Digital Lighting Controller has IEC mains output sockets, mainly because they will fit! However, practically all lights you can buy, especially Christmas lights, will be fitted with a standard 3-pin mains plug.

We recommended buying an IEC-to-3-pin-mains converter lead, such as that shown bottom left in the picture below. However, these are relatively expensive (~$10 each) so for eight channels it quickly adds up.

And what happens when (as you almost certainly will with Christmas lights) you want to plug in multiple lights into the same channel?

We have come up with a pretty cheap solution for both problems – and that is to use a standard 4-way mains power board (which you can buy anywhere these days for $3 or less!) and change the 230V mains lead over to one fitted with an IEC plug.

Where do you get such a lead? Call us bower-birds if you like but every time we have thrown out an old CRT monitor, we have cut off the mains lead (back in the early days CRT monitors used to plug into the computer via an IEC socket). Ergo, our junk box had several lengths of mains leads fitted with IEC plugs one end.

So for us, the only cost was buying some power boards (and we found a pack of four at Bunnings for $6.95!)

Don't have spare IEC cables on hand?

If you don't have the luxury of a well-stocked junk box, the alternative is to use a powerboard as is but change the mains plug over to an IEC type (as shown at right in the photo below). It's not quite as cheap (these plugs usually sell for about $7 each) but at least you get multiple outlets via the powerboard.

Opening up the powerboard

Usually, powerboards are assembled with tamper-proof screws – so you're going to need a tamper-proof screwdriver to remove them. (What self-respecting hobbyist wouldn't have a set of tamper-proof bits in his/her toolbox?).

Most we found simply use a slotted screw with centre raised section, which requires a slotted blade bit. However, we've also found them with star, Torx and other bits. Sometimes they are rivetted or welded together, in which case you can't do this modification. Check your powerboard before buying!

Remove the screws with whatever bit it takes and the two halves of the powerboard should separate. There will almost certainly be an overload circuit breaker built in – leave the brown wire connecting this to the Active bus bar but cut off the Earth wire where it connects to the Earth bus and similarly the Neutral (blue) wire where it connects to the Neutral bus.

Remove the Active (brown) wire where it connects to the input of the circuit breaker.

Invariably, the wires are all welded so they will have to be cut away. Replace the cable with your IEC-ended cable, cutting the brown, blue and green/yellow leads to the same length as those you removed.

Make sure the individual wires are mechanically secured to the bus bars (ie, wrap them around tightly) and then solder them in place. Replace the cover and you're done. SC

Left: our modified powerboard, now fitted with an IEC mains plug and cable assembly "saved" from a junked monitor.

Right: the alternative approach, fitting an IEC plug in place of the standard mains plug.

Above: an IEC mains plug to 230V mains socket adaptor, as originally recommended.

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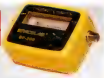

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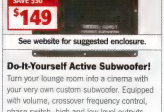

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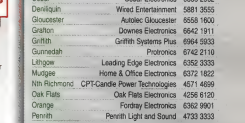

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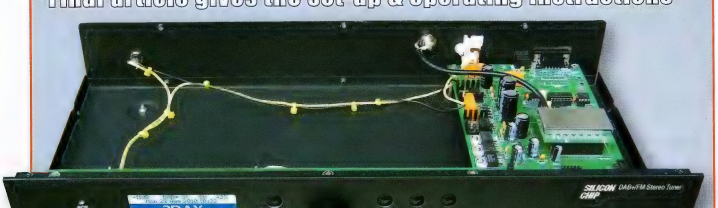
Final article gives the set-up & operating instructions



A high-quality DAB+ tuner to build

Pt.3: By MAURO GRASSI

In this month's final part, we explain how to use the DAB+/FM Stereo Tuner and describe the menu system. We also show you how you can upgrade the firmware if necessary and describe various features of the tuner in detail.

NOW THAT you've completed the assembly of the DAB+/FM Stereo Tuner, it's time to connect it to an amplifier and get it operating.

The first thing you'll need to ensure good reception is an antenna. If you are in a strong reception area, a simple "rabbit ears" antenna may be sufficient to pick up the digital stations but it probably won't be good enough for FM reception. Instead, we recommend that you use a roof-top TV antenna to ensure good reception of both the digital and FM stations.

If you want to listen to both DAB+ and FM stations, it is best to use a dedicated FM antenna. This is because DAB+ can operate at full quality with a much weaker signal than FM. Therefore, even if the FM antenna picks up the DAB+ stations with a fraction of the strength as for FM, it should still provide good digital reception.

If you are mainly interested in tuning in to DAB+ stations, a television antenna is a reasonable choice. This is because DAB+ channels in Australia occupy VHF Band 3 which also contains TV channels 6-12. Of course virtually all Australian television antennas will have elements to pick up channels 7, 9 and 10 and so they should also pick up the DAB stations on either side.

The ultimate solution would be to feed the signal from a VHF Band 3 antenna and a dedicated FM antenna into a combiner and then into the tuner. However, unless you are far away from the transmitters, a single antenna should do the job.

Navigating the menus

Pressing the Menu button brings up the menu system. You can then navigate to a sub-menu either by using the VOL-UP and VOL-DOWN keys on the remote or by using the rotary encoder. Pressing SELECT on the remote or pressing the encoder will then select that menu item.

You can also select a sub-menu directly by pressing the number key associated with it. A sub-menu item has square brackets which contain its menu number, whereas a simple menu uses round brackets.

Once inside a menu, you can use the encoder to vary the setting up or down, or you can use the VOL-UP and VOL-DOWN on the remote.

A menu is exited by pressing the DIMMER (EXIT) button on the remote or the EXIT/MODE pushbutton on the front panel.

You can also enter a numeric setting directly, in those menus which take a numeric setting. The display will change as shown in the screengrab of

Fig.7 and will give the minimum and maximum allowable settings.

As well as changing some of the default values in the menu system, you can also customise the splash screen.

When power is applied to the tuner, it initially displays a splash-screen bitmap for a second or so. However, if a memory card with a 160 x 80 monochrome bitmap file called "splash.bmp" (in the root folder) is inserted, this will be displayed instead of the default splash screen.

Initial set-up

The first time you turn the tuner on, the LCD should display the SILICON CHIP logo for about three seconds and then give a warning stating that no digital or FM stations have been programmed in. It should then default to 104.1MHz in FM mode.

So the first thing to do is to scan and store the local DAB+ and FM stations. This doesn't take long and normally only has to be done once, since the results are stored in non-volatile memory. However, if you move house, you will have to re-scan to store the new local stations.

Here's the scanning procedure for the two bands:

(1) Scanning For DAB/DAB+ Stations: to do a DAB/DAB+ scan, first enter the menu system by pressing the MENU button. This brings up the main menu, as shown in Fig.1.

That done, navigate to the DAB/DAB+ sub-menu using the UP and DOWN buttons on the remote (or use the rotary encoder), press SELECT (OK) and choose *DAB/DAB+ Scan*. Check that you have the antenna plugged in, then confirm the operation by pressing SELECT (OK).

The scan will take a couple of minutes at most. If all goes well, you will see the stations as they are found.

(2) Scanning For FM Stations: there are three choices here – you can perform either a NORMAL or STRONG FM scan, or you can load the FM stations from a file on the memory card.

To scan the stations in, go to the menu system and choose the "FM Menu", then go to the "FM Scan Level" sub-menu and select either a NORMAL or STRONG scan.

The difference between the two is the signal strength required for a station to be stored. A STRONG scan will only register stations with good signal strengths while a NORMAL scan will store weaker stations as well.

If you want to store all the FM stations in your area, you can load the FM stations from a text file on the memory card. A sample file can be downloaded from the December 2010 section of the SILICON CHIP website and is good for FM stations in Sydney, Australia. You will need to search on-line for the correct frequencies for your city.

All you have to do is create a text file with each frequency (in MHz) listed on a separate line (ie, one line per frequency). This file should be named "fm.txt" and placed in the root folder of the memory card. You then insert the memory card into the DAB+/FM Stereo Tuner, switch on and navigate to the ***FM Menu>Load Stations From File*** sub-menu. The list of stations will then be read in and stored.

LCD overview

Fig.2 shows a typical readout from the LCD during normal listening. The top two lines form the "Status Bar" and this shows the volume (or rather, attenuation in -dB) at top left. Alternatively, it will show "Mute" (when the tuner is muted), "Auto" when the muting is controlled automatically, or "Static" when the FM Stop Static feature is enabled.

The middle of the top line will typically show either "DAB", "DAB+" or "FM", depending on the station type. It will also show "ST" or "MONO" to indicate whether the broadcast is stereo or mono.

To the right of this, a blinking "IR" indicator will appear when infrared control signals are being received from the remote. In addition, when the "SHIFT" key on the remote is pressed, it will show "SH" (the shift key will time out if no key is pressed within a few seconds). Alternatively, when in FM mode, it will show "IN" (for input) when entering a frequency directly.

Finally, the far right of the top line shows the signal level as a percentage.

Fig.1: the main menu screen. There are 11 sub-menus to navigate through.

Fig.2: a typical readout from the LCD when the tuner is tuned to a station.

Fig.3: the LCD shows the mute status each time the MUTE button is pressed.

Fig.4: the second display mode shows the frequency spectrum amplitudes.

Fig.5: the third display mode shows an audio level scrolling ramp.

Fig.6: this display mode shows the radio text in a large font format.

Fig.7: menu settings can be altered using the VOL-UP & VOL-DOWN button on the remote control.

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Finally, the far right of the top line shows the signal level as a percentage.

Setting Up A Universal Remote Control

This panel explains how to use a universal remote control rather than the remote control supplied with the DAB+/FM Stereo Tuner kit. This may be necessary if the original remote is lost or becomes faulty. Alternatively, some constructors may prefer to use a universal remote.

As previously stated, you must use a universal remote capable of outputting RC5 codes (most do). A suitable remote is the Jaycar AR1726 and this should be set to the VCR 917 code or to some other Philips RC5 code (just follow the instructions supplied with the remote).

Other universal remotes will work just as well – just be sure to choose a Philips RC5 code.

Start by navigating to the ***Input Menu*** on the tuner, then choose the ***Define Remote Control Codes*** submenu. You will be prompted to enter a list of keys on the remote. At each stage, you should press the key on the remote that you would like to be the designated function.

For example, if you are prompted to "Press Pause", you should press the key on the remote control that you want to use for the Pause function (ie, mute).

At any time, you can press the EXIT/MODE pushbuton on the front panel of the tuner to abort the process. Pressing any other key on the front panel will skip that key's definition (for example, if your remote does not have enough keys, you can leave some undefined). You will get a warning saying "Duplicate Key, Try Again!" if you press a key that has already been used for a definition.

Once the process completes, the codes are saved to non-volatile memory.

Note that the above method can also be used to remap the keys of the supplied remote control, should you wish to do so. However, unless you have a specific reason for doing this, we suggest that you keep the defaults.

The second line of the status bar indicates the day, date and time. Below this, depending on which of four display modes (see below) is active, the station name, radio text string and other information will be displayed. This "main" area also displays "System Messages", which indicate that the tuner is responding to commands.

System messages

When you press the MUTE/PAUSE button on the remote, the LCD will briefly show either "Mute On" or "Mute Off" – see Fig.3.

In addition, there are quite a number of other system messages which make the tuner easier to use. These system messages are visible for a short duration only and then the normal display resumes. Here we explain what some of these messages mean (the rest are self explanatory):

NO DIGITAL COMPS: you will get this message if you attemp to switch to digital mode but no digital stations are registered. The remedy for this is to perform a DAB/DAB+ scan, as described above.

ENTER FREQUENCY: when in FM mode, pressing FF on the remote will allow you to directly enter the station frequency in MHz.

CARD EJECTED: this message will appear if a memory card is removed while the tuner is in operation. You should only re-insert the memory card when the tuner has been powered down, as the memory card is detected on start-up.

MODE ERROR: this is actually a runtime error, from which the tuner will recover as best it can. It should not happen in normal operation. It can be caused by an unexpected reset of the Venice 7 module.

First display mode

There are four display modes and you can select the next display mode by pressing the DIMMER (EXIT) key on the remote.

The first display mode is shown in Fig.2 and this shows the station name in a large font. The next line shows an audio information string, consisting of PTY (Program Type), codec name and the sampling rate and bit rate. A typical string will look like this: "Pop Music, AAC, 48.0 kHz & 96 kbs".

The PTY code is a numeric code transmitted by the station (either from a DAB/DAB+ station or an FM station that transmits RDS). The code gives information about the content being played, in the form of a broad category. Typical codes are "News", "Pop Music" and "Classical Music" (it gives limited genre information).

Codec information: the codec information only applies to digital broadcasts, and will be either "MP2" or "AAC". "MP2" refers to an MPEG-1 Layer 2 audio codec and is used in DAB broadcasts. "AAC" refers to HE-AAC version 2 and is the codec used by DAB+ broadcasts. AAC is more efficient than MP2 and allows better utilisation of the radio spectrum.

Sampling and bit rates: these rates apply to digital broadcasts only and are shown in kHz and kbs respectively. They give an indication of the audio quality of the encoding. In general, the higher the numbers the higher the audio quality.

Audio level display: the audio level appears below the audio information string and takes the form of a horizontal bar. It varies depending on the RMS value of the audio signal.

Radio text display: the radio text information (if any) is shown at the bottom of the display. This is either the DLS (Dynamic Label Segment) for DAB/DAB+ broadcasts or FM RDS text for FM stations. It will be blank for FM stations that do not transmit RDS.

Second display mode

The second display mode shows the frequency spectrum amplitudes (as well as maximums for each band, depending on the FFT mode setting in the Preferences sub-menu) – see Fig.4. Below that is shown the station name and system messages, and below that is shown the radio text.

Third Display Mode

Fig.5 shows the third display mode. This is the same as the second display

Start-up Warnings & Troubleshooting

The DAB+/FM Stereo Tuner is capable of issuing a number of warnings at start-up. These are as follows:

LOW CONTRAST: when the contrast is set too low, there will be a low contrast warning. The contrast is also temporarily set higher to enable this and other warnings to be seen clearly.

NO DIGITAL COMPS: this warning indicates that the tuner has no DAB/DAB+ components (ie, stations). In that case, go to the DAB/DAB+ submenu and perform a scan. Note that if there are no digital components, the tuner will start in FM mode and you will not be able to enter digital mode.

NO FM COMPS: this warning indicates that the tuner has no registered FM station frequencies. The unit can still be tuned to any FM station but it's best to perform an FM scan or load an FM station list from a memory card. Having registered FM components means that the CH UP and CH DOWN functions work faster (otherwise the tuner scans for a station each time).

DEBUG MODE ON: this indicates that debug mode is enabled. Debug mode should only be used for troubleshooting, as it will affect the responsiveness of the tuner.

LOG MODE ON: this warning indicates that logging is enabled. Logging should only be used for troubleshooting as it will affect the responsiveness of the tuner.

Run Time Error Reporting

The DAB+/FM Stereo Tuner can also issue run-time errors, similar to that shown in the screen grab of Fig.8. These should not occur in normal operation. Any error reports that do occur will indicate the program memory address that caused it. You should note the address and clear the error by pressing SELECT.

The errors are listed here and are useful for troubleshooting:

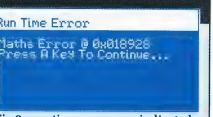

Fig.8: run-time errors are indicated on the LCD but should not occur in normal operation.

ADDR. ERROR: an address trap occurred.

MATHS ERROR: an ALU trap occurred.

STACK ERROR: a stack overflow or underflow occurred.

OSC. ERROR: a problem with the microcontroller's primary oscillator occurred.

RADIO NOT DETECTED ERROR: this will be reported when the microcontroller cannot detect the Venice 7 module. All radio functions will then fail to work. Re-install the Venice 7 module and check that it is working correctly if you receive this error.

mode except that instead of showing the frequency spectrum, an audio level scrolling ramp is displayed.

Fourth display mode

In this display mode, the radio text is shown in its normal inverted scrolling window at the bottom of the display and is also shown in large font in the main area of the display – see Fig.6. This allows the radio text to be read from further away. Below that is shown the station name, along with the audio level display.

Status bar

As mentioned above, the first line of the "Status Bar" shows the volume and signal strength, plus general information on the tuned station,

Below the first line is the date and time, as gathered from the radio signal – either from a DAB+ signal or from an FM RDS signal (if the FM station transmits RDS information). This line will show "Gathering Time . . ." while the tuner is retrieving the time and the time will be synchronised regularly.

The period that can elapse before the time is again synchronised is set by the ***Time>Time Update Period*** sub-menu. The default period is five minutes.

However, the time will also be synchronised when the tuner comes out of standby, since the time-keeping is shut down in this mode. That's because the microcontroller is in sleep mode during this period, so that it draws very little current.

The seconds display is optional and can be turned on or off by going to the ***Time>Time Display*** sub-menu.

General user operation

The tuner is easy to operate and can be used either with the supplied remote control or with a universal remote that can transmit RC5 codes.

If you elect to use the supplied remote control, there will be no need to program the remote control codes. However, if you are using a universal remote, you will need to program the codes first. This only needs to be done once and the procedure is set out in the panel titled "Setting Up A Universal Remote Control".

The tuner can also be operated using the front-panel controls. There are eight pushbutton switches, a power switch on the far left of the front panel and a rotary encoder with switch action.

Almost all functions can be accessed using the front-panel controls. However, some functions and some station presets can only be accessed using the remote control.

Normal operation

The tuner can operate in either DAB/DAB+ or FM mode and the interface for each is slightly different. Switching between these two modes is simply a matter of pressing the MODE UP (for DAB/DAB+) or MODE DOWN (for FM) buttons on the remote. Alternatively, you can toggle between the two modes by pressing the "EXIT/MODE" button on the front panel.

Once a station is tuned, you can use the VOL-UP and VOL-DOWN keys on the remote control to change the volume, or you can control the volume using the encoder knob on the front panel. The mute/pause button on the remote can be used to "silence" the audio at any time.

Sleep & standby modes

Pressing the "Sleep" button on the remote (top, centre) switches on the screen saver. When that's done, the display brightness dims to the level set in the ***Display>Sleep Brightness*** submenu. We call this the "Sleep Mode".

Understanding The Technical Terms

Sony/Philips Digital Interconnect Format (S/PDIF): a standard for transferring digital audio data. The standard uses bi-phase encoding and is self-clocking.

Inter-IC Sound (I^2S): a standard 4-line inter-IC bus for transferring digital audio data.

Inter-IC (I^2C): a standard 2-line inter-IC serial bus for transferring data at relatively low data rates. It allows many devices to share a common bus and to be individually addressable.

Digital Audio Broadcasting (DAB/DAB+): a method for broadcasting digital radio signals, in use around the world. DAB+ is superior to DAB and is the standard used in Australia. DAB and DAB+ are not compatible. A significant difference between them is that the latter uses a more efficient audio codec.

Frequency Modulation (FM): a method of encoding audio onto a carrier frequency, where the deviation from the carrier frequency corresponds to the amplitude of the audio. It is more resistant to noise than AM but requires greater spectrum space.

Advanced Audio Coding (AAC): a standard lossy audio compression format, used by the Venice 7 module for DAB+ radio reception.

MPEG2-Audio Layer 1 (MP2): a standard lossy audio compression format, used by the Venice 7 module for DAB/DAB+ reception.

Program Type (PTY): a numeric 5-bit code that contains information about the program currently on the tuned station. It pre-dates DAB/DAB+ and in fact, is used in the FM Radio Data System (RDS).

Radio Data System (RDS): a standard for transmitting small amounts of data on top of a standard FM radio signal. It can be used to transmit radio text (song and artist information), station information, program type information and time information, among other uses.

Dynamic Label Segment (DLS): a standard way of transmitting small amounts of data on a standard DAB/DAB+ radio transmission. Functions analogously to RDS on FM.

Normally, this would be set to a low value (ie, a low percentage of full brightness). In addition, when the time-out period set in the ***Display>Timeout*** sub-menu expires (without a key press), the screen saver is invoked automatically.

The screen saver shows the time and date, station name and any radio text information.

However, if the sleep brightness setting (***Display>Sleep Brightness*** sub-menu) is set to zero, the tuner will go into "Standby Mode" instead. This will occur both when the "Sleep" button is pressed on the remote and at the end of the time-out period.

"Standby Mode" is different to "Sleep Mode". While the latter simply invokes a screen saver, the microcontroller will still be fully operational. On the other hand, in "Standby Mode", the microcontroller enters low-power mode and is essentially shut down except for minimal functions. In this mode, the display switches off but the radio keeps operating.

During "Standby Mode", the blue indicator LED (LED3) flashes periodically (provided the LED brightness, as set in the ***Display>LED Brightness*** sub-menu, is not set to zero).

You can press the red "Standby" button on the remote to place the tuner in standby mode at any time too. Pressing any key on the remote or on the front panel switches the tuner back out of standby or sleep mode.

Storing & using presets

You can store up to 10 preset stations for DAB/DAB+ mode and 10 for FM mode. Once these have been stored, pressing a digit from 1-10 on the remote loads the corresponding preset station, depending on the mode.

Alternatively, you can access the first six presets for either mode using the 1-6 front-panel switches.

If a preset has not been set for a particular button, you will get a "Preset Empty" message on the display.

To store a preset, first tune to the station that you want to store, then press "SCAN" on the remote followed by the digit number for the preset. The tuned station will then be stored as a preset. This procedure works in both DAB/DAB+ and FM modes.

Note: the "SCAN" key acts like a shift key. Pressing and holding this down before pressing another key enables an additional function.

At any time, you can use the "MENU" button to enter the menu system. The accompanying panel titled "Navigating & Using The Menu System" describes the menu system in detail and details how the settings are changed.

Changing stations

Once the stations have been scanned and stored, you can press the "CH-UP" and "CH-DOWN" buttons to change to the next or previous station. The digital stations are sorted alphabetically by name, while the FM stations are sorted by frequency from the lowest to the highest.

Pressing the "SELECT" button on the remote brings up a list of stations on the LCD. You can then select a station by scrolling up or down the list using the VOL-UP & VOL-DOWN or CH-UP & CH-DOWN keys on the remote and pressing the SELECT button.

Alternatively, pressing the DIMMER (EXIT) button on the remote control will abort the selection.

You can also change stations by pressing the encoder knob and then using the encoder to scroll up or down the list. Pressing the encoder knob again then selects the highlighted station.

In FM mode, you can also press the FF button on the remote and enter in the station frequency directly using the numeric keys on the remote. You then press the FF button again to tune to the entered frequency. For example, if you are in FM mode, you can press FF, 1, 0, 2, 5, FF to tune to 102.5MHz.

Playing back WAV files

In order to play back uncompressed WAV files from the memory card, you must first store the files on the memory card with a ".wav" extension. You then insert the memory card into its slot (on the front panel) while the tuner is powered off (note: you should always insert the memory card when the power is off, as the memory card

Upgrading the Firmware

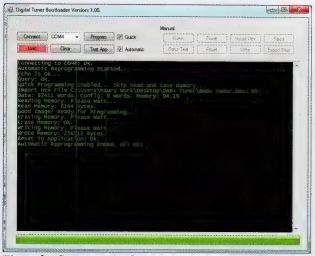

Fig.9: the firmware in the tuner's microcontroller can be upgraded by running the dabt.exe utility (see text).

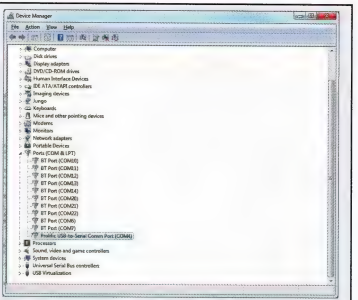

Fig.10: you can check your PC's COM port number via Device Manager. In this case, a USB-serial converter is being used.

The DAB+/FM Stereo Tuner incorporates a bootloader program (in microcontroller IC1) which allows its firmware to be updated via the serial port. This is done using a PC and the supplied program ***dabtb.exe*** (available on the SILICON CHIP website).

To upgrade the firmware, you will need the new firmware image (this is a .hex file), the ***dabtb.exe*** executable, a serial cable and a Windows-based PC with a serial port.

It is important that power is maintained during the firmware update. If power is accidentally lost, you will have to start the update procedure all over again from step 1 (see below).

Before proceeding, note that all stored settings (apart from the defaults) will be lost after a firmware upgrade. This will include any station presets and remote control codes. The way around this is to save all your stored settings to a file on a memory card, then restore them later on.

Automatic update

The easiest way to update the firmware is to use the automatic option. The step-by-step procedure is as follows:

(1) Save your existing settings to a file on the memory card. This is done by navigating to the ***System>Save Settings To File*** sub-menu).

(2) Connect the tuner to a Windows-based PC using a serial cable. If your PC doesn't have a serial port, you can use a USB-Serial converter, such as the Jaycar XC-4834 (most notebooks lack a serial port).

(3) Boot the PC and download the ***dabtb.exe*** program from the SILICON CHIP website.

(4) Start the bootloader by applying power to the tuner while holding down the MENU button on the front panel. Alternatively, the bootloader can be entered through the menu system (***Advanced>Boot Loader***). Note that if you press the "EXIT/MODE" button on the front panel while the boot loader is active, you will exit the boot loader (this will not work if the program memory has been erased).

(5) Once the bootloader has started, the LCD will be blank (with its backlight off) and the blue LED on the front panel will flash periodically. This means that the tuner is in bootloader mode and is ready to receive commands from the PC through the serial port.

(6) Run the ***dabtb.exe*** application on the PC. This will bring up a dialog window as shown in Fig.9 but with the text area initially blank. It has a number of buttons and a LINK check box which is green when there is a connection (it's red otherwise).

(7) You must know which COM port you are using to connect to the tuner. If you are using a native COM port (usually only desktop PCs will have one), it will be either COM1 or COM2. Alternatively, if you are using a USB-serial converter, the COM port number could be different.

You can check the PC's COM port number by going to "Control Panel" and then to "Device Manager". This will show the hardware installed on your system. The COM port number will be listed under "Ports (COM & LPT)", as shown in the screen grab of Fig.10. In this particular case, the relevant port is the "Prolific USB-to-serial Comm Port (COM4)", which indicates that we should use COM4.

(8) Once you have determined the correct COM port number, select the correct number from the drop-down list (COM ports from COM1 to COM16 can be chosen), then click the "Connect" button. If all is well, you will get a "Connecting to COM4: Ok." message in the text box.

If you don't get this message, you may have the wrong COM port selected or the driver for your USB-serial converter (if you are using one) may not be installed correctly.

(9) Press the "Program" button to start reprogramming the firmware. If all goes well, you will be asked to browse for a hex file and then, after a few minutes, the process should end without errors. The tuner should now boot into the new firmware version the next time it is powered up.

You can check that the firmware has indeed been updated by going to the ***System>Firmware Information*** sub-menu.

(10) Restore your settings from the previously-saved memory card file by going to the ***System>Restore Settings From File*** sub-menu.

Navigating & Using The Menu System

This section describes the menu system and the various settings in detail. The menu system will need to be used only rarely, as the settings are stored in non-volatile memory and the defaults will be suitable for most users.

Each menu consists of a number of entries and each entry can be a menu or a sub-menu. The menus are as follows:

DAB/DAB+ Menu

DAB/DAB+ Scan: used to scan digital radio stations. You must confirm the scan by pressing OK. Pressing any other key or letting the confirm menu time out will abort the scan.

If you confirm the scan, the tuner will immediately begin scanning for stations. This can take up to two minutes to complete and the stations detected are stored in non-volatile memory.

You must perform a scan at least once before using the tuner and you will need to repeat the procedure if you move to a different city or suburb. Regular scans will ensure that your station list is up to date.

DAB/DAB+ Band: enter this menu to select the DAB/DAB+ band of operation for the tuner (note: the tuner is capable of working on three separate frequency bands).

In Australia, Band 2 (87.5-108MHz) is used for FM broadcasts, while VHF Band 3 (174-230MHz) is used for digital radio.

The default setting of "Australia/Europe" enables both Band 3 and L-band for DAB/DAB+ and is correct for Australia. Other possible settings are:

Korea: use this setting for Korea;
Canada: use this setting for Canada;
UK: use this setting for the UK;
Band 3: VHF Band 3 reception only;
L-Band: UHF L-band reception only.

Station List: this shows the station list for DAB/DAB+. The list is updated every time you perform a DAB/DAB+ scan. Each station's name is shown and you can press the VOL-DOWN key to scroll down the list. Press EXIT (DIMMER) to exit the station list.

Frequency List: this shows the list of DAB/DAB+ frequencies in MHz. You must perform a scan before this list is updated. Press the VOL-DOWN key to scroll down the list and press EXIT to exit the frequency list.

Restore Defaults: you will be asked to confirm this action. If you do, the default DAB/DAB+ menu settings are restored.

FM Menu

FM Scan: enter this menu to scan in FM stations. You must confirm the scan by pressing OK. Pressing any other key, or letting the confirm menu time out, will abort the scan.

If the scan is confirmed, the tuner will search for FM stations. Two types of scan can be performed, a STRONG or NORMAL scan. The STRONG scan will only pick up stations that have a strong signal, whereas the normal scan will pick up all stations, even those that have a weak signal.

Selecting a STRONG or NORMAL scan is done in the ***FM Scan Level*** sub-menu. The whole scan can take a couple of minutes and the detected stations are stored in non-volatile memory. You should perform a scan at least once before using the tuner and, as before, you must perform a scan if you move to a different area or suburb.

Note that for FM, it is not necessary to perform a scan if you have a list of the station frequencies in your area. In that case, you can use the ***Load Stations from File*** sub-menu to load the stations directly. This option is recommended if you are in a weak signal area or in an area where there are many weak stations.

FM Scan Level: this menu lets you change the scan mode to either STRONG or NORMAL. As explained above, this affects the threshold for locking onto an FM station, during an FM scan. If you are in a weak signal area, you would specify NORMAL, otherwise specify STRONG to store only strong-signal stations.

Load Stations From File: use this menu to load a list of FM stations from a text file called "fm.txt" in the root folder of a memory card. The tuner will read this file and update the station list. A sample file for Sydney, Australia can be downloaded from the SILICON CHIP website. Each frequency should be on a separate line (with hard carriage returns).

Stop Static: if enabled, this will automatically mute static (noise) in FM mode.

Station List: this shows the list of FM stations (ie, frequencies). You must perform an FM scan or load the station list from a file before this list is updated. The frequencies for FM reception are shown in MHz. Press the VOL-DOWN key to scroll down the list and press EXIT to exit this menu.

Restore Defaults: you will be asked to confirm the action. If you do, the default FM menu settings are restored.

System Menu

This menu can be used to save and restore settings to the memory card. It can also provide useful information for troubleshooting.

Firmware Information: this menu shows the firmware version and the Venice 7 firmware version. This is useful for troubleshooting.

Save Settings To File: use this menu to save all settings to a file on the memory card. This also saves any remote control codes which have been defined. You should do this once you are happy with your settings. The file can then be used in the future to restore your settings, if necessary.

The file is saved to "setYYYYMMDDhhmmss.bin", where YYYY is the year, MM is the month, DD is the day, hh is the hour, mm is the minutes and ss is the seconds (ie, the date and time when the file was saved). You will need to confirm the action.

Restore Settings From File: use this menu to restore all settings, including any custom remote control codes, to those previously saved in a "*.bin" file using the menu above. You will need to confirm the action.

Display Menu

This menu controls all settings to do with the LCD and LED3 on the front panel.

Brightness: use this menu to set the brightness of the LCD module's LED backlighting. The setting is a percentage of full brightness.

Contrast: allows you to set the contrast of the LCD module. The setting is a percentage.

Timeout: this controls the duration of

the timeout period. If no key presses are detected for the duration of this period, the tuner will go to "sleep". In this mode, the display will dim and show the time. The tuner can then be woken again up by pressing any key.

The default timeout value is 10 minutes but can be set anywhere between one second and nine hours. A value of "0" disables the timeout.

Sleep Brightness: this is a percentage that sets the brightness of the LCD module's LED backlighting when the unit is in "sleep" mode

LED Brightness: this controls the brightness of LED3 on the front panel.

Restore Defaults: use this menu to restore all display menu settings to their default values.

Audio Menu

This menu is used to change the audio settings, as follows:

Audio Fading: you can enable or disable audio fading. When enabled, the audio will fade in from maximum attenuation to the set volume when a new station is tuned.

Use Hardware Mute: enable this to only use the hardware mute circuit for muting the tuner, rather than a software mute. The default is software muting.

Audio DRC (Dynamic Range Control): used to vary the dynamic range compression. It allows you to change the compression applied to the DAB/DAB+ audio stream. The possible settings are NONE, HALF, FULL and TWICE. The default setting is FULL which applies the recommended amount of DRC embedded within the broadcast data.

You can choose to turn off DRC altogether by selecting NONE, or use only half (HALF) DRC. Alternatively, you can double the normal level of DRC (TWICE).

Input Menu

This menu can be used to check that the input devices are all working.

Check Keys: use this menu to check that the tuner correctly recognises remote control signals and correctly decodes the front panel pushbuttons. The key code is displayed on the first line ("Key"), along with the translated code ("Tr. Key"). The number of bits and protocol of the IR signal is also shown.

The DAB+/FM Stereo Tuner can recognise both 12-bit RC5 codes from a universal remote and 32-bit codes from the supplied remote control. If checking the front panel pushbuttons, that will be indicated too.

Check Encoder: used to check that the rotary encoder on the front panel PC board is working correctly. The display should change according to whether the rotary encoder is turned clockwise or anticlockwise.

Key Repeat Period: changes the time period between repeated key presses. The setting is shown in milliseconds.

Define Remote Control Codes: use this menu to define the remote control codes if you are using a universal RC5 remote control. You will need to follow the on-screen prompts. Pressing a pushbutton on the front-panel PC board will skip the key (if you press EXIT/MODE on the front panel, you can abort the process altogether).

Note that you will only need to do this if you wish to use a different remote control to the one provided with the kit (see panel).

Check Serial Port: use this menu to check that serial port communications between your PC and the tuner are working correctly. The tuner will echo back any received character and display it on the screen.

You can use a terminal program for your PC such as realterm.exe (Real Terminal, freely downloadable from sourceforge.net). The tuner's serial port is configured for 115,200bps, 8 bits, 1 stop bit and no parity.

Preferences Menu

This menu changes the way text appears on the LCD. The default settings should be suitable for most people but you can also customise them to suit your own preferences.

Radio Text Delay: sets the scroll rate for the DLS (dynamic label segment) or FM RDS (radio data service) information string. The higher the delay, the slower it scrolls

Radio Text Shift: typically, this should be set to "1" for smooth scrolling. Increase this number to shift in blocks of more than one column. If you are going to increase this setting, you would normally also increase the Radio Text Delay setting to avoid the text changing too rapidly.

Station Name Mode: there are three options here, as follows:

(1) No Scrolling: in this mode, the station names are shown without scrolling. That is, if the name of the digital station is too long to fit on the display, the font is reduced to make it fit. This is the default option.

(2) Scrolling: in this mode, the station names are shown in the largest font at all times. If the name is too big to fit inside the window, it is scrolled.

(3) Short Names: in this mode, the station names are shown in the largest font at all times. Only the short name of the digital station is shown (which is an abbreviation of the full name).

Window Delay: the higher the delay, the slower the windows containing the station name and audio information will scroll. The default setting should be suitable in most cases.

Window Mode: there are two options here:

(1) Normal: the middle windows are shown normally, with the text composed of white pixels on a blue background. The status bar and radio text display areas are inverted.

(2) Inverter: the middle windows are inverted from the NORMAL setting. This is good for extra contrast.

FFT Mode: there are four options here:

(1) Left & Maximums: spectrum is left justified, with lower frequencies to the left. Maximum indicators are shown.

(2) Centre & Maximums: spectrum is symmetrical about the centre. Maximum indicators are shown.

(3) Left No Maximums: spectrum is left justified, with lower frequencies to the left. No maximum indicators are shown.

(4) Centre No Maximums: spectrum is symmetrical about the centre. No maximum indicators are shown.

Restore Defaults: used to restore the default preference menu settings.

Time Menu

Time Display: there are two options here:

(1) Basic Time: in this mode, the weekday, date (including day, month & year) and the time in hours and minutes (24-hour format) are shown.

(2) Show Seconds: the same as Basic Time mode but with seconds also shown.

Time Update Period: this is the time that elapses before the tuner's clock is re-synchronised to the time signal received from either a DAB/DAB+

. . . continued next page

Navigating & Using The Menu System . . . ctd

signal or FM RDS time data. Note that not all FM stations transmit RDS information, so the time may not be accurate if tuned to an FM station that does not transmit RDS.

The time display will change to "Gathering Time . . ." while the tuner is synchronising the time with the broadcast signal.

Advanced Menu

This menu will rarely need to be used, if at all. It's there for troubleshooting purposes or for upgrading the firmware in the microcontroller.

Firmware Information: this menu shows the microcontroller firmware version and the Venice 7 module firmware version.

Debug Mode: this is useful for troubleshooting. Debug mode can be used to see the packets between the microcontroller and the Venice 7 module using the serial port and a terminal emulator. The possible settings are:

(1) On: this should only be enabled for troubleshooting, as it will slow down the responsiveness of the tuner to commands.

(2) Off: in normal operation, select Off to disable debug mode.

Bridge Mode: used to enable or disable bridge mode. Bridge mode can be used to troubleshoot any problems with the Venice 7 module itself

In this mode, the microcontroller acts as a relay between the serial port and the Venice 7 module, meaning the Venice 7 module can be controlled directly from a PC through a serial connection. This mode is not used at consumer level.

Boot Loader: used to enter the boot loader to allow firmware upgrades to the microcontroller (should upgrades become available). The procedure is described in a separate panel titled "Upgrading the Firmware DAB+/FM Stereo Tuner".

Radio Factory Reset: restores the factory defaults for the Venice 7 module. This will delete all stored DAB/DAB+ stations, so a rescan will be required.

Restore Radio Defaults: use this submenu to restore all the tuner's default settings. It will not delete stored DAB/DAB+ stations from memory, though.

Reset: restarts the tuner.

Memory Card Menu

Memory Card Information: this menu is used to display information about the memory card. This includes its serial number, the type of card (ie, MMC, SD or SDHC), its name, capacity and free space, etc.

Eject Memory Card: lets you remove the memory card without losing information. All logging writes are finalised, after which the card can be removed.

Logging Menu

This menu allows you to enable logging to the memory card and can be useful for troubleshooting purposes. It will rarely need to be used, if ever.

Log Mode: used to enable logging. There are two options:

(1) Off: all logging is disabled.

(2) System: only system events are logged.

Log Session Size: this sub-menu lets you set the maximum size of the log file on the memory card. If the limit is reached, subsequent log requests will be ignored. Note that the log file is cleared at boot time.

Show Log: used to view the log file.

detection occurs on start up).

Pressing the INFO button on the remote ("Play") starts playback of the uncompressed WAV files on the memory card. This also brings up a menu on the LCD which shows the directory structure of the memory card. Only files with a ".wav" extension will be displayed.

If the WAV file contains metadata information specifying the song title, this will be displayed, otherwise the filename itself is displayed. You can select a file by pressing SELECT on the remote control or by using the rotary encoder on the front panel.

Note that you can use freeware such as Audacity (**http://audacity.sourceforge.net**) to convert your music to WAV format. You can also use Audacity to resample a track or to add artist and title information that the tuner will recognise.

Automatic muting

Another feature of the tuner is automatic muting. This takes place when changing stations in both digital and FM modes. Basically, the audio is muted until the microcontroller detects a signal on the output of the Venice 7 module (this is done using the I²S connection from the Venice 7 module). When a signal is detected, the muting is automatically switched off.

Note that the volume display on the LCD shows "Auto" while ever the automatic muting is enabled. The automatic muting can be disabled by pressing the MUTE button (top left) on the remote.

FM "stop-static" feature

Enabling the "Stop Static" feature (*FM>Stop Static* sub-menu) allows the automatic muting to cut in if static is detected in FM mode. When this happens, the audio is muted while ever the noise remains.

The following conditions must be met for the audio to remain muted:

(1). The signal must be so weak that the station is received in MONO (if a stereo FM signal is received, the muting will not work); and

(2). The microcontroller (which monitors the I²S bus) determines that the signal contains static due to its relatively constant level.

The volume display will show "Static" while ever this feature is active. However, static detection is not foolproof and can be manually overridden if necessary using the MUTE button on the remote. Alternatively, it can be disabled altogether via the FM sub-menu.

Finally, note that a complete kit of parts for this project is available from Jaycar Electronics, Cat. KC5491. SC

Errata

DAB+/FM Stereo Tuner, Pt.1, October 2010: the LM317T regulator on the main circuit (Fig.1, p.27) should be designated REG4, while the LM3940 immediately above it should be designated as REG5. The parts layout diagram in Pt.2 (Fig.3, p.71, November 2010) is correct.

Hearing Loop Level Meter

Last month, we described the circuit for the Hearing Loop Tester and gave the assembly details. This month, we show how to build a calibration coil and adjust the tester so that it gives accurate results. We also describe how the unit is used.

Pt.2: By JOHN CLARKE

HAVING COMPLETED the assembly, the Hearing Loop Tester is ready to be calibrated. As previously mentioned, the unit must be adjusted so that the 0dB LED lights for a magnetic field strength of 100mA/m. This is done by placing the meter in a known magnetic field and adjusting trimpot VR1.

One possible method involves using a single 1-metre diameter turn of wire fed with 100mA at 1kHz. An amplifier set to deliver 0.82V RMS via an 8.2Ω 0.25W resistor could be used to drive the coil.

However, to achieve correct calibration using this method, inductor L1 would have to be accurately located in the centre of the coil. That's because the field strength varies depending on L1's position relative to the centre position of the loop.

A more practical calibration method involves using a Helmholtz coil (see **http://en.wikipedia.org/wiki/Helmholtz_coil**). A Helmholtz coil comprises two identical parallel on-axis coils that are driven by the same signal. These two coils are separated from each other by the coil radius (Fig.6).

A feature of a Helmholtz coil is that it gives a constant field along the axis between the two coils. This field remains constant to within 1% inside a central concentric area out to about half the diameter of the coil.

The current required in each coil to give a field strength of 100mA/m is 0.1398 x R/n, where "R" is the radius in metres and "n" is the number of turns in each coil. In our case, we decided to design the coils so that they have only one turn each (to make construction easy) and can be driven by the headphone output of a PC.

In practice, a 130mm-radius coil is suitable and this requires a coil current of 18.16mA to give 100mA/m. This is achieved by connecting the coils in series and driving them with a 600mV AC signal via a 33Ω resistor.

Fig.6 shows the assembly details for our Helmholtz calibration coil. It's built using 2.4mm diameter steel (fencing) wire, a 200 x 65mm length of timber, some hook-up wire and a 33Ω resistor. You will also need two screw terminals, a cable clamp, some shielded cable and a 3.5mm stereo plug.

As shown, the 2.8mm steel wire is looped to form two 260mm-diameter coils. To do this, first cut two 836mm lengths and bend them down by 90° about 10mm from each end. That done, drill two sets of 3mm-diameter holes at each end of the timber to hold the wire ends. Each hole pair should be 8mm apart and the two pairs should be separated by 130mm (see Fig.6).

The hook-up wire and 33Ω resistor can now be soldered to the ends of the steel wire. It's then just a matter of bending the steel wires into loops and feeding the hook-up wires and the resistor down through the baseboard holes. The ends of the wire loops can be pushed into these holes to hold them in place.

Use small cable clamps (if necessary) to hold the coils in place and make sure that the ends of each coil don't short together. Use heatshrink to insulate them if necessary.

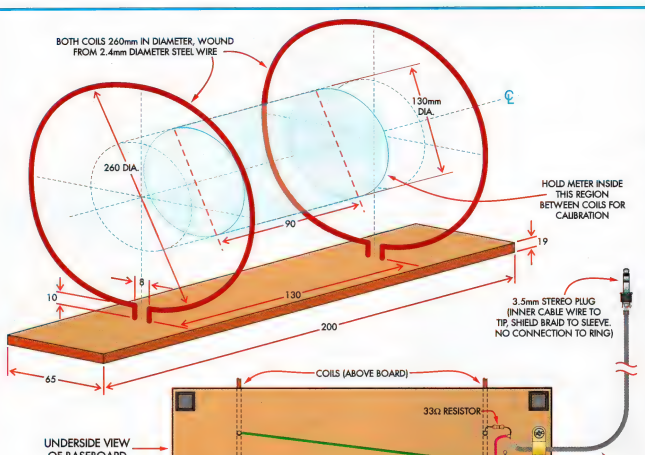

Fig.6: follow this diagram to build the Helmholtz calibration coil. The two loops are made from steel fencing wire and are connected in series and driven with a 600mV 1kHz sinewave signal via a 33Ω resistor – see text.

Once the coils are in place, follow the wiring diagram of Fig.6 to complete the connections to the multimeter terminals and the stereo plug. Note that the ring terminal of the 3.5mm stereo plug is left open circuit. **However, a mono jack plug can not be used since it would short out the right channel of a stereo socket.**

The cable to the 3.5mm stereo jack plug is held in place onto the timber using a suitable clamp. This clamp can be fashioned from some scrap aluminium or formed by soldering two solder lugs together.

Finally, adjust the two coils so that they are vertical and parallel to each other and are aligned along the same axis. However, while the construction needs to be reasonably accurate, it does not have to be perfect. Small variations in the coil radius and position do not affect the field strength by much, so this should be well within 3dB of the theoretical value.

Driving the coils

The coils can be driven using a 1kHz signal generator and a suitable amplifier to deliver a 600mV AC signal. Alternatively, you can use a software sinewave generator and the soundcard output from a PC to drive the coils. The latter method will be the most used, so we'll concentrate on that.

We tested two free software generators. The first comes from BIP Freeware and can be downloaded from **http://www.electronics-lab.com/downloads/pc/005/index.html** It's available as a compressed file named *sine30.zip*.

To use this program, unzip the files to *c:\program files\sine30* and create a shortcut to *sine.exe* on the desktop.

The controls are easy to use. **Make sure the mute is switched off and on again after every change in frequency, otherwise the signal becomes corrupted.** The output level can be varied over 255 steps using the volume control – see Fig.7.

The second recommended sinewave generator is available at **http://www.diffusionsoftware.com/sinegen.php** Download and run the *SineGen_V1_0_setup.exe* file. The relevant files will be placed into *c:\Program Files\Little SineGen* and you should create a shortcut to *SineGen.exe* on the desktop.

Now run the program and select the soundcard driver. That done, set the output frequency to 1kHz by dragging the Frequency and the Divide sliders (the latter must be set to 1) – see Fig.8.

Depending on which program you

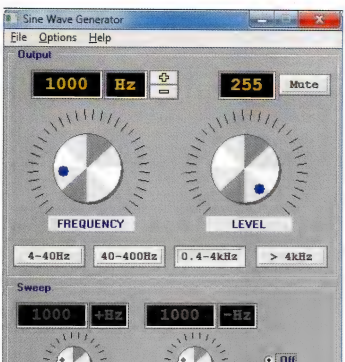

Fig.7: this software sinewave generator from BIP Freeware can be used to generate the 1kHz sinewave signal.

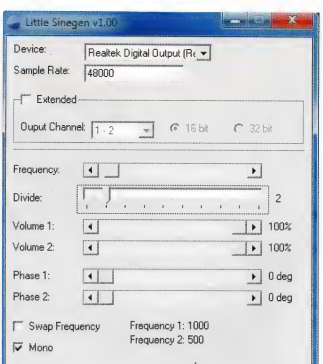

Fig.8: another suitable sinewave generator program is *Little Sinegen* from Diffusion Software.

choose, the output level is adjusted using either the level control or the volume control. If there are sound problems with either sine generator, go to the sound properties dialogs (eg, in Control Panel) on your PC and check the various audio level adjustments.

Setting the signal level

With the sinewave generator now operational and set to 1kHz, plug the Helmholtz coil assembly into the PC's audio output socket (green). The applied signal level should now be checked and adjusted using a multimeter that's accurate for readings up to 600mV at 1kHz.

If the meter is not accurate at this frequency, then set the generator to the highest frequency that the multimeter can accurately measure and adjust the level to 600mV. The output frequency should then be set back to 1kHz for the calibration.

As an example, the multimeter we used has a claimed accuracy of 2% from 45-500Hz on its lowest AC voltage range (3.2V). As a result, we set the sinewave generator to 500Hz, adjusted the output level for a reading of 0.6V AC on the multimeter and then set the generator back to 1kHz.

If your DMM is only accurate up to 50Hz, then it is not sufficiently accurate to set the level from a computer sound card. That's because most sound cards do not have a flat frequency response down to 50Hz, ie, the output level at 50Hz will be less than at 1kHz. Note, however, that you can adjust the level at 50Hz if you are using a "standalone" signal generator and an amplifier, provided the amplifier has a flat response down to 20Hz.

During calibration, make sure that any equaliser settings on the computer (or tone controls on the amplifier) are set for a flat response. The calibration procedure is as follows:

(1) Set the driving signal level to 600mV AC and the frequency to 1kHz as described above;

(2) Hold the Hearing Loop Tester (without its lid) between the two coils. The unit should be held horizontally (ie, with the LED bargraph horizontal) and with its pick-up coil (L1) centred within the measurement area.

(3) Adjust trimpot VR1 so that the 0dB LED (LED3) just lights.

(4) Check that both coils are working by moving the Hearing Loop Tester along their axis. The signal strength should remain consistent at 0dB over the 90mm range depicted on Fig.6 and should be 3dB down (LED4 lit) if the pick-up coil is directly centred inside each coil.

If the signal strength varies along the axis (ie, within the 90mm range), it's probably because a coil is not working. In that case, check for shorts at the bottom of the coils, where they attach to the timber.

That completes the calibration procedure. The Hearing Loop Tester is now ready for use.

Checking background noise

Checking the background noise prior to installing a hearing loop is important. This will help ensure that the loop is not affected by excessive noise due to mains wiring and/or any nearby equipment.

According to Australian Standard AS60118.4-2007, environmental noise should not be any more than -20dB A-weighted with respect to a 100mA/m field (or -40dB with respect to a 1A/m field strength). At this level, the -21dB LED on the meter should either be off or just beginning to light.

The Hearing Loop Tester is calibrated by holding it horizontally inside the centre-region of two wire loops and adjusting VR1 for a 0dB reading on the bargraph. The loops are driven with a 1kHz 600mV sinewave signal.

Note that if a hearing aid loop is already installed, it must be switched off when making environmental noise measurements. **Note also that the unit must be held vertically when making both noise and field-strength measurements.**

In order to make the A-weighting measurement, jumper LK1 must be out of circuit. However, before proceeding, we should comment on the AS60118.4-2007 environmental noise standard and the A-weighting used for the measurement.

Basically, the standard assumes that if the measured background noise level is 20dB below the 100mA/m reference level, then the area will be suitable for a hearing loop. However, our tests don't bear this out in practice.

Instead, we found that if the environmental noise is only just below -20dB with respect to the 100mA/m field, then the noise is too high for acceptable loop performance. In short, any signal from the hearing loop will be dominated by noise.

It seems that the measurement standard for background noise is not stringent enough. And the reason for this is that an A-weighted measurement response masks out the major source of noise which happens to be at 50Hz and 100Hz. A-weighting rolls off these frequencies at -30dB and -19dB respectively, before the noise measurement is taken.

Ditching A-weighting

We found that doing away with the A-weighting gives a better indication of background noise levels. **By installing link LK1, the meter has a much better response over the 50-100Hz region and this gives a better correlation between noise measurements and the noise that is actually heard in a hearing aid (or hearing loop receiver) when picking up loop signals.**

As a test, we set up a loop, fed it with an audio signal and monitored it with the SILICON CHIP Hearing Loop Receiver described in the September 2010 issue. We also monitored the signal levels using the Hearing Loop Tester.

We then introduced various noise sources to the loop (eg, a mains cord connected to a fluorescent lamp) and checked the audible noise levels. By then turning the audio signal off, we were also to check the noise levels on the tester.

This showed that the indicated noise levels on the tester were well matched to any audible noise from

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the receiver but only when LK1 was installed (ie, no A-weighting). With A-weighting selected, the tester gave no indication of background noise even when it made listening to the wanted signal quite difficult.

So we recommend leaving LK1 in position when making noise measurements. In this configuration, noise levels will be satisfactory if they are at -21dB or less, assuming the tester is correctly calibrated (ie, either the bottom-most LED or no LEDs should light). This measurement recommendation is actually more stringent than the AS60118.4-2007 environmental noise standard.

Field-strength measurements

Field strength measurements should be made using a 1kHz sinewave as the signal source for the loop amplifier. If you do not have a signal generator, you can use one of the software generators described above.

If the hearing loop is a part of a sound system which also uses loudspeakers, the 1kHz tone should be set to the normal listening level. The hearing loop amplifier is fed with a signal from the main sound system.

It's then just a matter of adjusting the signal level from the hearing loop amplifier so that the 0dB LED just lights on the meter.

By increasing the driving frequency (but keeping the level the same), you can use the tester to check frequency response of the loop from 1-5kHz. This will show up any high-frequency drop-off in the field strength due to inductance effects in the loop.

Generally, it's not necessary to check the loop response below 1kHz since inductance effects do not affect low frequencies. It's not necessary for the low-frequency response of the hearing loop to go below 100Hz.

If you do decide to check the loop's response down to 100Hz, remember that the tester rolls off its low-frequency response. For the wide setting, with LK1 inserted, its response is 3dB down at 200Hz and 6dB down at 100Hz. This means that if the meter reads -6dB at 100Hz, then the loop response is actually flat to 100Hz. Similarly, if the meter reads -9dB at 100Hz, then the loop response is -3dB at 100Hz.

Final checks

Once the signal levels have been set and the frequency response checked, the loop can be tested with normal program material, such as speech. If the amplifier includes a VU meter, adjust the volume control to give the same average VU level as for the 1kHz sinewave signal. Peak levels on the VU meter should be ignored.

Fig.9: here are the full-size artworks for the front and top panels.

The Hearing Loop Tester can also be used to set the amplifier output to provide the correct 0dB level with normal program material. In practice, measured loop field strength levels will vary depending on the signal applied to the loop. If the loop amplifier includes a compressor or if the Silicon Chip Hearing Aid Loop Signal Preconditioner (to be described) is used, then the signal level will be relatively constant.

Finally, note that the meter has a slow response. This has been done so that it averages the signal level over time. This allows it to display the long-term average level without indicating individual signal peaks (which would be misleading). SC

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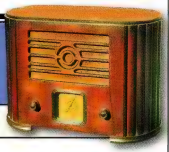


By RODNEY CHAMPNESS, VK3UG

The Philco 40-40 4-Valve Mantel Set

Designed as a "wartime special", the Philco 40-40 is simple 4-valve receiver that was manufactured in Sydney in 1940/41. It's a compact reflexed design with some interesting features.

RADIO RECEIVER design has gone through many phases, both in regard to circuit design and cabinet styling. The very first designs were basically crystal sets but there were also sets that used other forms of solid-state detectors. Valves were only just being developed at that time and in any case, the early types were much too expensive for experimenters to buy.

The next phase saw the development of coffin-style radios based on one or more valves. These were often built by experimenters, with the parts laid out on a breadboard. This was then housed in a coffin-style cabinet to protect the wiring.

Coffin-style receivers were superseded in the late 1920s by commercial receivers built on metal chassis. The period leading up to WWII was a time of rapid development in both component and circuit design and many excellent receivers were produced.

The Great Depression hit hard during the early 1930s and manufacturers responded by producing simple receivers at low prices. As the depression receded, more elaborate designs were again produced towards the end of the 1930s. Then along came WWII and the emphasis changed again.

Because of military demands, component supplies were restricted during the war years and manufacturers had to use whatever they could obtain. As in the Great Depression, the emphasis was on austerity. However, radio design had progressed considerably over this decade and the WWII austerity models are considerably better than those of the depression years.

One local manufacturer from that era was Philco Radio and Television Corporation (Aust.) Pty Ltd. Based in Auburn, NSW, they produced radio receivers from the 1930s through to at least the mid-1950s. These covered the complete range, from simple receivers up to complex multiband sets.

The Philco set described here is an austerity WWII model, circa 1940-41. It was designated the "40-40" and is a 4-valve set with a reflexed IF/audio amplifier stage.

General details

The Philco 40-40 is basically a compact mantel receiver. It's housed in a Bakelite cabinet but despite its compact size, it still weighs in at 4.5kg. This particular set has a cream cabinet although it's fairly certain that brown cabinets would also have been available and there may have been other colours as well.

As shown in the photos, the dial scale on the Philco 40-40 is square-shaped. The pointer, however, is attached to the tuning gang shaft and sweeps through a 180° arc to cover a nominal frequency range of 550-1600kHz. A simple dial-cord drive couples the tuning control to the dial drive drum and the dial cord will be easy to replace when the time comes.

A 5-inch (125mm) electrodynamic speaker is mounted on the lefthand front of the chassis and the unit fitted to this particular set was still in surprisingly good condition. There are

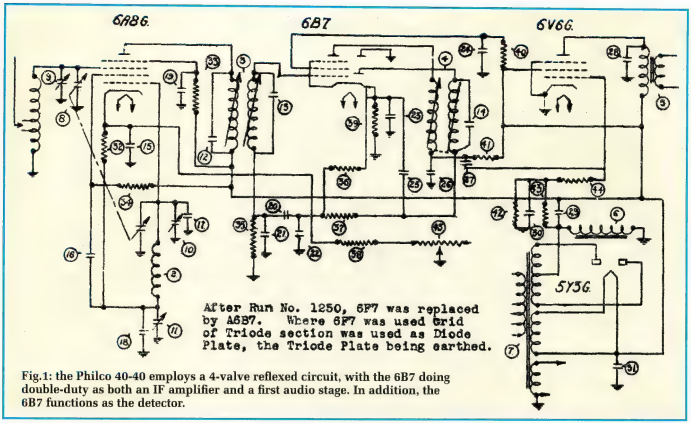


Fig.1: the Philco 40-40 employs a 4-valve reflexed circuit, with the 6B7 doing double-duty as both an IF amplifier and a first audio stage. In addition, the 6B7 functions as the detector.

just two controls, located beneath the dial scale: the volume control at left and the tuning control at right. There is no on/off switch – after all, this was a WWII austerity model.

Crowded house

From the rear of the receiver, it can be seen that things are quite crowded above the chassis. In fact, there is only about 5mm between the tops of some valves and the inside top of the cabinet. The same applies to one of the IF transformers. This chassis was really shoe-horned into the cabinet!

Despite this, the chassis is easy to remove from the cabinet. It's just a matter of removing the two knobs at the front and the three screws that go through the bottom of the cabinet into the chassis. The assembly then slides out.

I initially didn't notice that the cabinet had been repaired during a restoration several years ago. The repair job was expertly done and only close inspection reveals the colour-matched fibreglass matting covering some extensive cracks.

Circuit details

Now let's take a look at the circuit – see Fig.1. This is a 4-valve reflexed receiver and for those unfamiliar with the concept, take a look at Vintage radio for July 2010.

Unfortunately, the way that the circuit has been drafted leaves quite a lot to be desired. As an example, resistor 38 and potentiometer 45 on the cathode of the 6A8G could easily have been positioned to the left of the valve and arranged vertically. That way, their function would have been much more obvious at first glance.

The antenna coil is a flat basket-weave type of the style commonly fitted to portable receivers. It's located at the righthand end of the chassis and has two tappings so that the most appropriate one can be selected to suit the antenna being used.

As shown on Fig.1, the output of the tuned circuit is fed to the signal grid of the 6A8G which functions as a converter. In this particular set, a 6J8G has been fitted although a 6A6G is the correct type to use. The oscillator section uses a single coil winding (2), with the "earthy" end going to the relevant valve grid to give the necessary feedback to induce oscillation.

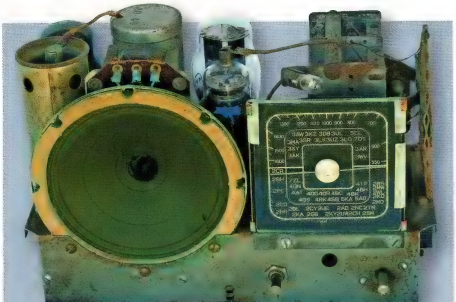
This receiver does not have AGC so the cathode circuit is connected to earth via a 300Ω resistor (38) and a series 7.5kΩ potentiometer (45). The setting on the pot determines the bias on the signal grid of the 6A8G and hence its gain. This in turn controls the volume of the receiver.

IF stage

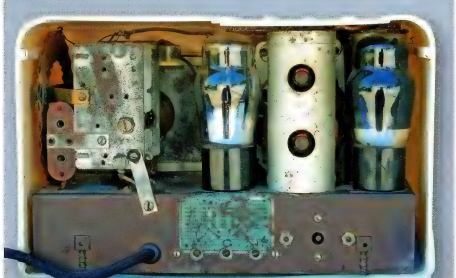
The intermediate frequency (IF) signal appears at the plate of the 6A8G and is fed through two tuned circuits in the first IF transformer to the grid of a 6B7. This functions as the IF and first audio valve. Here, the signal is amplified and then fed via a single-tuned IF transformer to one of the detector diodes in the 6B7.

Note that the circuit indicates that this second IF transformer is double tuned, as both windings appear to have tuning slugs. However, the secondary has no fixed capacitor across it, so it is not tuned and there is no adjustment for that winding (AWA also often used this same style of IF transformer to feed the diode detector). Once again, the draughtsman has been careless in drawing the circuit.

The detected audio is fed to the grid of the 6B7 via resistor 37, capacitor 20 and the secondary winding of the first IF transformer. The resulting amplified audio signal appears across a 100kΩ resistor (41) and is applied via capacitor 37 (10nF) to the grid of a 6V6



This front view shows the compact nature of the chassis. Despite this, it still manages to include a 5-inch (125mm) electrodynamic loudspeaker.



The chassis is a tight fit, with barely 5mm between the tops of the valves and the inside top of the cabinet. All the alignment adjustments are accessible via holes at the back of the chassis.

audio output valve. This then drives the electrodynamic loudspeaker via a speaker transformer.

Note that the cathode of the 6V6G is earthed and its bias is supplied via a back bias network from the power supply.

Power supply

The power supply is a little unusual in that the field coil/filter choke (6) is wired into the negative lead to earth. The more conventional method is to connect it in series with the positive HT lead from the rectifier filament.

The back bias for the 6V6G audio output valve is developed across the field coil. This bias is applied to the 6V6 via a resistive divider consisting of a 250kΩ resistor (43) and a 100kΩ resistor (42). This divider reduces the back bias voltage to around -12V, which is optimum for a 6V6G. A 100nF capacitor (30) filters any hum on the back bias line.

Note that the earth at the junction of (42) and (30) is poorly shown in the circuit diagram (it really is a confused circuit schematic). The labelling of the various power transformer input taps is missing too. This makes it necessary to measure the voltages on the filament lines in order to be sure that the correct terminals have been used.

My tests revealed that the transformer has three primary winding taps to suit voltages centred on 200V, 240V and 260V AC. I also discovered that the person who originally restored this set had wired the mains Neutral to a tap and the Active to the common transformer terminal. That's certainly not the recommended way to do it.

On the circuit diagram, it states that a 6F7 was originally used in the IF/audio preamplifier stage but this was changed to a 6B7 after run 1250. All the valves in this set are octal except this one valve but they may have had lots of 6B7s in stock and wanted to use them (the 6G8G is the octal equivalent). It's also possible that some valves types were unavailable during the war years and they had to make do with what was available.

Chassis layout

The components used in this compact mantel set are all full-sized. As a result, the designers had quite a job on their hands when it came to shoehorning everything into the available space. As mentioned earlier, the space between the valves and the inside top of the cabinet is just 5mm.

Both the front-end parts and the power supply components are adjacent to the power transformer which is mounted under the chassis, directly below the tuning gang. The oscillator coil is right alongside the power transformer, while the converter valve is at the front of the chassis, near the loudspeaker and the tuning gang.

The 5Y3G rectifier is located at the back of the chassis next to the tuning gang, while the 6B7 is at the lefthand end of the chassis (viewed from the front) alongside the speaker transformer. The (shiny) second IF transformer is underneath the chassis, while the 6V6G sits on top of the chassis in the back lefthand corner.

Because of its layout, this isn't an easy set to work on and it can be difficult to identify particular leads, especially when they disappear under other parts. The wiring colours have also faded and this adds to the difficulty of tracing individual leads.

One quite interesting aspect of the layout is that all the antenna, oscillator and IF adjustments are accessible from the back of the set, without removing the chassis from the cabinet. In par-

ticular, the trimmers for the antenna and oscillator circuits are accessed via three holes along the bottom edge of the back skirt of the chassis.

The designers must be applauded for this unique idea, which makes alignment much easier than otherwise.

Restoration

This receiver had been restored several years ago, prior to my friend buying it. This meant that it required only minor work to get it back to peak performance.

As can be seen in the photos, the chassis has surface rust but the set itself is quite clean. Unfortunately, stripping it down to remove the rust would be a huge amount of work. As a result, it was decided to leave it as it was and simply restore the circuit to proper working order.

The mains cord Earth lead had originally been soldered to the chassis, which was considered satisfactory in years gone by. This had subsequently been changed by terminating the Earth lead with a crimp connector and fastening this to one of the transformer mounting bolts (see photo).

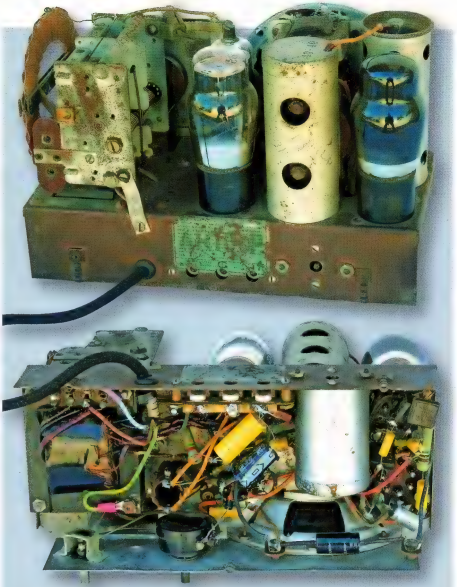
I wasn't happy with this and bolted the earth lead crimp connector to the chassis instead. A separate earth lead was then run from one of the transformer mounting bolts to a second chassis earth point. In addition, the Active and Neutral leads were transposed on the power transformer by resoldering them to the correct terminals.

The method used by a previous restorer to secure the mains cord was quite primitive and is completely unsatisfactory. It should be properly secured using an approved chassis clamp and the owner will attend to this when he takes the set home.

The paper capacitors had all previously been replaced, as had the electrolytic capacitors. I wonder how the old ones fitted in, as they would have taken up quite a lot of the space under the chassis and space really is at a premium.

Unfortunately, some of the replacement parts have been fitted with their values obscured. Wherever possible, I always fit resistors and capacitors so that their values can be easily read. This makes it much easier to service a set should it later require attention.

For some reason, the previous restorer had installed a 700pF mica capacitor in the padder circuit of the oscillator instead of a 475pF capacitor as specified. This error was discovered when I later switched the receiver on (see below).



The parts are tightly packed together on both the top and bottom of the chassis, although access is still reasonable. Note the primitive method used by a previous repairer to secure the mains lead. It should be secured using an approved chassis clamp, while the Earth lead should be bolted directly to the chassis, rather than secured to a transformer mounting screw.

Initial tests

It was now time to test the receiver. I began by checking the leakage between the windings of the power transformer using my high-voltage tester and this showed that it was in good order. In addition, there were no shorts or near shorts on the HT (high tension) line.

Having completed these checks, I connected a meter to the HT line and applied power. The HT shot up to over 400V initially, which is normal in a receiver with a loudspeaker field-coil filter. It then settled down to about 250V as the valves began drawing current.

Alignment

The next step was to attach an antenna to one of the antenna coil taps. When I did this, the set immediately began working. What's more, it seemed quite sensitive, with lots of stations coming in.

Because the Philco 40-40 has no AGC (automatic gain control), I had to constantly adjust the volume control as I tuned across the broadcast band. AGC certainly has its advantages and

continued on page 103

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Power for multiple DI boxes

I am interested in the Direct Injection Box project featured in the August 2001 issue. I would like to build four of these DI units and house them together in a single metal box.

My main concern is whether I would be able to power all four units from a single on-board power supply instead of separate plugpacks, as described in the power supply section of the article. At this stage, I also feel that I don't want the 9V battery supply as I will either power the units from the 48V phantom or on board power supply.

My thoughts for the on-board power supply are to use the ±15V Universal Power Supply (Silicon Chip, August 1988) and a 12-18V multi-tapped 1A transformer. This would be wired as shown in Fig.4 (unregulated single supply version) and the corresponding component layout shown in Fig.9. My hope is that the said power unit will supply the required power to run the combined four units.

Would the stated power unit combination be satisfactory and capable of supplying the necessary power? If not, what would I need to meet my requirements? (D. W., via email).

● Each DI circuit draws about 9mA and so four such units would only require 36mA. This can be easily supplied via a single 9V DC plugpack that can supply 36mA.

If you decide to use a mains transformer and the universal power supply arranged in a single-ended DC output, then a 12V 150mA transformer is all that is required. We do not recommend using a mains transformer supply as it would introduce hum into the DI signal. A single external DC plugpack is a better way to power the four units.

Question on fluorescent lamps

I'm asking if you could help me with this question. I do not understand why I cannot put two fluorescent lamps in parallel. (F. M, Tunis, Tunisia)

● Have a look at how a conventional fluorescent lamps works on **http://en.wikipedia.org/wiki/Fluorescent_lamp**

As you will see from the description, a fluorescent lamp needs a ballast (ie, an iron-cored inductor) to generate the high-voltage spike needed to start the discharge. If you had two lamps in parallel, only one is likely to fire.

Doubts about digital radio

Digital TV often stammers with picture and sound. With digital radio we can't have this – I wouldn't want to miss a soft note in a Beethoven sonata or when I listen to a key change in Beethoven's third movement of the ninth. Can I be sure that digital radio is flawless? (A. H., via email).

● As far as we know, DAB+ does not get the stammers. It either works or it doesn't. On the other hand, FM broadcasts will be with us for some years to come, so you can still listen to those.

EHT stick resistor voltage ratings

With regard to the EHT Stick in the April 2010 issue, I'm curious how the maximum input voltage of 25kV was arrived at, given this results in only about 300V across the 1.6kV rated resistors.

Extrapolating from the 1.6kV allowed across each 10MΩ resistor gives a maximum input of 128kV. This would result in an input current of about 0.16mA and a power dissipation per 10MΩ resistor of about 0.25W – well within their rating of 0.5W. Granted you wouldn't want to take too long with the measurement, as this means the whole stick is dissipating 20W (0.25W x 80 resistors).

The output resistors would be well within spec also, as the output voltage

Adding A Mains Transformer To The DAB+ Tuner

I plan to build the DAB+/FM Stereo Tuner but would prefer to fit a toroidal transformer inside the case and connected to an IEC socket. Would putting a transformer inside the case compromise the performance? If so, would an aluminium sheet cage around the transformer (or some other approach) solve the problem? (B. D., via email).

● The DAB+/FM Stereo Tuner was designed to be able to accept a centre-tapped transformer as well as an AC plugpack as the power source.

If you are going to use a transformer, it should be centre-tapped and you should fit an additional two 1N4004 diodes below D1 and D2 to provide the full bridge rectifier. The centre of the centre-tapped transformer then connects to GND while the other two leads connect to the outer two pins of CON1 (ie, one connects to the anode of D1 the other to the anode of D4).

You can see the four diodes in the photo on page 29 of the October issue of Silicon Chip (near CON1).

The extra two diodes required for full-wave rectification were taken out in the published version because they are not needed when using an AC plugpack (which uses half-wave rectification). This was simpler for constructors because no mains wiring is involved.

It is doubtful whether an aluminium shield would have any effect. A shield made of steel would be better but if you are using a small toroidal transformer, hum should be negligible.

would only be 128V (not exactly a safe level though). Is the 25kV maximum input due to PC board leakage, the expected insulation quality of the DWV tube, some statutory requirement or just an artificial limit for the safety of your readership?

I have no intention of measuring such voltages. I'll probably never measure more than about 2kV but I am curious as this wasn't addressed in the article. I'm also curious as to the purpose of the heatshrink tubing, as it appears to me to serve no purpose but to possibly lull the user into a false sense of safety. Will the heatshrink stop 25kV?

And finally, would applying a PC on-board lacquer be a good idea to prevent humidity etc from affecting the probe's resistance and hence accuracy? Or would the lacquer break down at such voltages? (A. W., via email).

● You are quite correct in deducing that the 25kV limitation given for the EHT Stick HV Probe was purely an artificial and conservative one, to ensure the safety of readers and constructors. The first prototype used standard 0.5W metal-film resistors and we worked on the basis that they would be able to withstand at least 312V. They did so, quite happily.

We also worked on the basis that the inter-pad spacing on the board should also be able to withstand at least this voltage level and this also proved to be the case. However we suggested the use of an overall heatshrink sleeve as an extra "belt and braces" precaution, to help keep out moisture (which could provide a leakage path on the board surface).

Applying a conformal PC board lacquer to both sides of the board (after the solder joints are made) would probably be more effective than the heatshrink sleeve in keeping out moisture.

We would definitely not use the EHT Stick for measurements above 25kV. Higher voltages present the risk of flashover inside the tube or down the outside, due to dust or grime on the plastic surface.

Troubleshooting The 24V 40A Speed Controller

I am at my wit's end. I have assembled your 24V 40A DC Motor Speed Controller (SILICON CHIP, March & April 2008) as a kit from Altronics but I have not been able to get anything to work.

I have assembled literally hundreds of kits over the 52 years I've been in electronics and I am very well-versed in soldering and troubleshooting. I have followed the circuit down to the last detail, including all the published errata I can find for the project. The circuit has been point-to-point checked with a multimeter and as a back-up, I purchased another set to do a back-up board.

Whilst the 5V SMPS works fine and DC voltages appear at the correct points on the microprocessor, I have run the CRO over all of the points where I would expect a signal and there is no life anywhere. I would expect at least a signal coming from pin 6 but there appears to be nothing. A second microprocessor gave the same result.

On the other hand, I admit that my hands-on experience with microprocessors such as the PIC16F88-I/P is limited. I first expected some sort of clock signal being generated at pins 15 and 16. However, as these pins are being used as driver pins for display digits 1 & 2, I presume that the clock is set internally in the INTIO2 mode.

Whichever way, I would have expected some sort of clue from some point that the unit was alive. What simple test can I do with a multimeter and/or a CRO to see whether I have life in the micros? (S. W., via email).

● The easiest way to check that the microcontroller is working is to connect the small display board. As long as the supply voltage is 5V that should work.

If you don't see the display light up, it probably means there is a problem with the microcontroller. Check all the supply lines to it. If they check out OK and it is correctly orientated, then it may be that it is not programmed correctly. You may have to contact Altronics in that case.

Ultrasonic cleaner with portable transducer

I have a commercial ultrasonic cleaner and have experienced limitations with the size of the unit. I am seriously thinking of building the Ultrasonic Cleaner (SILICON CHIP, August 2010) but to have the transducer able to be inserted directly into various sized containers such as a kitchen tidy bin or a garbage bin. The size of the object would determine the size of the bin.

The article mentions that the cleaning effectiveness is reduced by larger sized baths. With this unit, what is the largest size bath that could be realistically used? Also what would be the maximum length of cable?

Rather than use standard 2-core sheathed mains I was thinking of using industrial sheathed mains. Also, is it possible to increase the maximum time from 10 minutes? My commercial unit can run for up to 30 minutes. (G. F., via email).

● The length of wire between the transducer and the ultrasonic cleaner is not critical and a 5-metre length would be OK. The wire must be mains (250VAC) rated.

The ultrasonic cleaner is best used in a container of 20 litres or less since the ultrasonic cleaning effect is reduced with larger containers.

Extending the time can be done by changing the .asm file. For the time to be longer by a factor of 3, the line *sublw D'45' ; narrow timer period calibration* would have the 45 changed to 135 and for the line *sublw D'17' ; wide timer period calibration*, the 17 is changed to 51.

```
;Line 401
TIME_TEST
incf TIMER1,f
movf TIMER1,w ; timer multiplier
btfss MODE,0
goto TIME_W
sublw D'45' ; narrow timer period
  calibration
goto TEST1
TIME_W
sublw D'17' ; wide timer period calibration
TEST1
btfsc STATUS,C ; if over clear
goto DRIVE
clrf TIMER1
decf TIMER,f
goto DRIVE
```

School zone alert causes interference

I have built the School Zone Speed

Operating The Christmas Lights Sequencer At 24VAC

What a brilliant kit. I will definitely be buying and building this one when it comes out. This will work brilliantly with a giant Christmas tree made of lights I'm planning for this year.

A quick question on a possible modification: could you run the outputs on 24VAC instead of 230VAC? Most LED Christmas lights work at 24VAC. I want to use a single high-current 24V transformer and run all of my lights off this (think Jaycar MP3045). Instead of having 230VAC connections to the output units, could you use the same circuit but have 24V connections (such a terminal strip or other low voltage connectors instead)?

I understand from the article that the latching current of the Triacs may be a problem. If it's not too late, could you consider if this possible modification warrants a side box in the next article? Again, a great design and one I'm really excited about (and yes I'm a tragic fan of the Christmas Vacation movie). (N. W., via email).

- The slave module should be able to switch 24VAC for LEDs without modification. There are two disadvantages to doing this and as you point out, some advantages.

Firstly, for the same amount of lighting power, the unit will need to switch roughly 10 times as much current. With LEDs this may be OK as they are much more efficient than incandescent lamps anyway but you may still be looking at several amps per channel, requiring a beefy input power connector.

Secondly, even if the light current is the same, the voltage loss across each Triac becomes a more significant proportion of the total, reducing the efficiency. This is exacerbated by the higher currents required as the voltage loss in the Triac is proportional to the current it switches.

Practically speaking, neither of these problems will prevent you from using the slave module to control 24VAC. You will just need to use different connectors at both ends. The latching current will probably not be an issue since, as explained, at lower voltages you will typically have higher currents for the same lighting power anyway. If it is a problem there is a way to circumvent it which is explained in the second article, in the November 2010 issue.

Alert and it works well but I have a 2-metre radio in the vehicle and it picks up noise plus the clock function on 147.00MHz exactly. As yet, I have not been able to suppress it. Would your designer give me a solution? (R. B., Bondi, NSW).

- The first things we would suggest, in order to reduce noise radiation from the School Zone Speed Alert, would be to loop both the 12V input lead and the lead out to LED1 through small ferrite toroids a few times, as close to the Speed Alert as possible. Each lead should be looped through its own toroid and ideally through the toroid about five or six times.

If that doesn't solve the problem, you may need to glue a rectangle of copper sheet inside the Speed Alert's box as a shield plate and connect this to the earth copper on the unit's PC board. And if even this still allows spurious emissions to cause trouble with your 2m radio, you may have to fit it inside a cast aluminium case instead of the plastic case, to provide better shielding again.

Ideal projects for schools

I would like a list of projects that would suit Year 12 students for their major works (under 32V or run from plugpacks, relatively cheap, less than $300, etc). I would really value and appreciate your advice and assistance in this area. (G. D., Toormina, NSW).

- Here is a list of projects we think are suitable, with an emphasis on those currently available as kits and recently published. The list is chronological, with the latest projects published first. Note that many more SILICON CHIP projects can be built by students but these are listed, given your emphasis on "major works".

In addition, provided Year 12 students have proper supervision by experienced teachers or technicians, there is no reason why they could not build any project that we have published, including those which involve mains power. We know of many Year 12 students who have built elaborate audio systems, car instrumentation set-ups, whole suites of measurement equipment and so on.

The list is as follows:

(1) Dual Tracking ±19V Power Supply, June-July 2010: Altronics kit K3218 $199.00: can be built as a plugpack-powered version with no mains wiring, although the resulting output power is somewhat limited.

(2) Air-Quality Meter for checking CO & CO_2 levels, June 2010: not a kit but can be built with parts from Jaycar and a PC board & programmed microcontroller from RCS Radio. Estimated cost $150.

(3) Solar Lighting Controller, May-June 2010: Altronics kit KC6028, $89.95. Additional parts required: 5W solar panel ($35), 3.3Ah SLA battery ($15.95), LED lamps.

(4) Compact 12V 20W Stereo Amplifier, May 2010: Jaycar kit KC5495, $44.95 (no heatsink); Altronics kit $49.95 (including heatsink). Additional parts required: enclosure, connectors, some mounting hardware, 12V battery or plugpack.

(5) Digital Audio Signal Generator, March-May 2010: Altronics kit K2553, $149. Additional parts required: 4 x AA batteries and/or 9V DC plugpack.

(6) Deluxe 3-Channel UHF Rolling Code Remote Control, August-September 2009: Jaycar kit KC5458, $64.95; Altronics kit K1940, $59.95. Additional parts required: 12V DC plugpack, enclosure and some connectors.

(7) SD Card Music & Speech Recorder/Player, August 2009: Altronics kit K5545, $74.95 (currently on special for $55). Additional parts required: 12V DC battery or plugpack, SD/MMC card.

(8) 6-Digit GPS-Locked Clock, May & June 2009: no kit but can be built with parts from Jaycar/Altronics and a PC board & programmed microcontroller from RCS Radio. Estimated cost $200.

(9) GPS-Synchronised Clock, March 2009: Altronics kit K1129, $48.95 + K1131 GPS module, $99. Additional parts required: a motorised wall clock.

(10) Theremin Mk.2, March 2009: Jaycar kit KC5475, $74.95. Additional parts required: AC plugpack.

Changing A Transformer's Secondary Voltage

How do you use a 25V-0-25V transformer for the 15W Class-A amplifier? It requires 21V-0-21V. Can I unwind the transformer? (P. K. via email).

- Toroidal mains transformers normally have the secondary winding as the outside winding. There are two ways of reducing the voltage.

You could wind extra turns for the two 25V windings in the opposite direction to the original windings to reduce the voltage. You would probably need about eight turns. If you find that the voltage is higher, then the new windings are wound in the wrong direction. In that case, just rewind the turns in the opposite direction.

Alternatively, you can take the secondary turns off. Again it is probably about eight turns each that are required. For other types of transformer that require disassembly, altering the output is not recommended.

(11) 433MHz UHF Remote Switch, January 2009: Jaycar kit KC5473, $44.95. Additional parts required: enclosures, batteries, 9-12V DC plugpack.
(12) Multi-Purpose Car Scrolling Display, December 2008-February 2009: Altronics kit K4352, $78.95. Additional parts required: enclosure, some connectors, 9-12V DC plugpack.
(13) PIC-Based Musical Instrument Tuning Aid, July 2008: Altronics kit K1124, $54.95. Additional parts required: 9V plugpack and/or 9V battery.
(14) 12-24V High-Current DC Motor Speed Controller, March-April 2008: Jaycar kit KC5465, $89.95; Altronics kit K6005, $69.95. Additional parts required: enclosure, connector, motor, high current power supply (eg, car battery).
(15) Remote Water-Tank Level Meter, November 2007 – January 2008, Jaycar kits KC5460, $110 & KC5461 $84.95. Additional parts required: small water tank for demonstration purposes.
(16) Radar Speed Gun, November-December 2006: Jaycar kit KC5441, $99.95. Additional parts required: small 12V battery pack.

Using the mic preamp with a pick-up sensor

I've read the article in the September 2010 issue on the High-Performance Microphone Preamplifier by Nicholas Vinen and it looks very good indeed. Would a piezo film pick-up/sensor be able to be connected to this preamp using a JFET source follower buffer such as the first one described in the following link? – **http://personalpages.tds.net/~fdeck/bass/quickand.pdf**

Incidentally, I've tried the sensor with this buffer feeding into a bass amplifier (Line6 Studio 110) and it works quite well, albeit rather quietly; once pressed against the instrument, flex and therefore output is reduced considerably, so some form of adjustable high-quality gain boost such as this preamp would be ideal just before the main amplifier's input stage.

- You can certainly use the microphone preamplifier in that manner although the JFET buffer may add some distortion to the signal. You don't need the AC-coupling at the output of that circuit since the microphone preamplifier has an AC-coupled input.

Another idea which might be worth trying is to increase the input impedance of the microphone preamplifier so that it can be used with a piezoelectric pick-up directly. We haven't tried it but it should work. You would need to replace the AD8648 with an AD8664 (CMOS op amp), replace the four 100kΩ resistors in the input circuitry with 10MΩ (leaving the 100kΩ at the output alone) and delete the two 10kΩ resistors attached to LK1. SC

Notes & Errata

Railpower Mk.4, September 2008: on the circuit diagram (Fig.2), the 10kΩ resistor shown between the collector and emitter of Q9 should be removed. The parts overlay diagram (Fig.1 in October 2008) is correct and does not include this resistor.

Ultrasonic Cleaner, August 2010: the regulator output voltage at pins 1 & 8 of IC1's socket (ie, with IC1 out of circuit) should be measured with fuse F1 out of circuit. Without the fuse, Mosfets Q1 & Q2 are prevented from providing a partial conduction path that may otherwise blow the fuse or cause some current flow through the transformer.

The fuse and IC1 can be inserted with power off once the regulator voltage has been checked (it should be between 4.85V and 5.15V).

DAB+/FM Stereo Tuner, Pt.1, October 2010: the LM317T regulator on the main circuit (Fig.1, page 27) should be designated REG4, while the LM3940 immediately above it should be designated as REG5. The parts layout diagram in Pt.2 (Fig.3, page 71, November 2010) is correct.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine.

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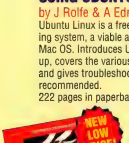

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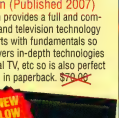

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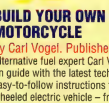

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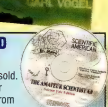

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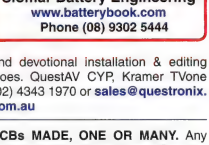

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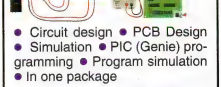

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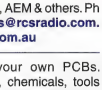

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Vintage Radio — continued from page 95

in this set, could easily have been applied to the converter stage.

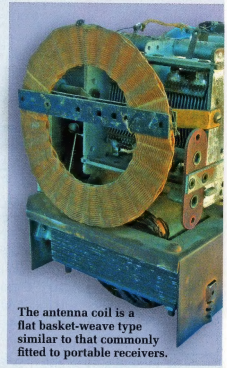
One thing I noticed was that the stations weren't quite where they should be on the dial. As a result, I decided to start the alignment procedure with the local oscillator.

Testing revealed that the receiver was tuning even lower in frequency than the IF (460kHz), which was decidedly odd. It was then that I found the 700pF fixed padder capacitor that had been fitted by the previous restorer, instead of the 475pF capacitor specified.

I replaced the padder with the specified value and was then able to correctly align the oscillator stage. Once that had been done, the stations came in at their correct locations on the dial.

Finally, the loop antenna was adjusted for optimum performance at around 1500kHz by peaking the associated trimmer capacitor (9). This was done with a long-wire antenna connected first to one antenna tap and then the other.

The old Philco receiver was now really hitting its straps and it really does perform well for a 4-valve austerity model set. In fact, on the strongest local stations, the volume could only be reduced down to a comfortable listening level, although it could be adjusted for zero output on weaker stations. There's a good reason to prefer sets with good AGC systems and audio stage volume controls.



The antenna coil is a flat basket-weave type similar to that commonly fitted to portable receivers.

Summary

This is an interesting little receiver that's well worthwhile having in a collection. Despite being a "wartime special", it's quite a good performer although it would have benefited by having AGC.

As mentioned above, all the alignment adjustments are accessible without removing the chassis from the cabinet. This feature is unique to this set as far as I know and it's certainly very convenient.

Finally, because the parts are so tightly packed into the chassis, this would not have been easy to service when using full-sized components. The designers certainly did a good job getting so much into such a small cabinet. SC

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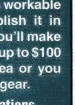

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Advertising Index

4D Systems	62
Agilent Technologies	62
Altronics	74-77
Avcomm	63
Bitscope	5
Dick Smith Electronics	24-25
Digital Graphics	103
Dyne Industries	6
Emona Instruments	45
Futurlec	64
Gless Audio	63
Grantronics	102
Harbuch Electronics	9
Hare & Forbes	3
H. K. Wentworth	16
Intellecta	102
Instant PCBs	103
Jaycar	IFC,49-56,104
Keith Rippon	102
Kinsten Pty Ltd	102
Kitstop	102
LED Sales	102
Microgram Computers	IBC
NPA Pty Ltd	9
Ocean Controls	91
PCBCART	6
ProtoGear	10
Quest Electronics	102
RCS Radio	102
RF Modules	OBC,104
Screenscope	29
Sesame Electronics	102
Silicon Chip Binders	59
Silicon Chip Bookshop	100-101
Silicon Chip Order Form	19
Siomar Battery Engineering	102
Soundlabs Group	10
Splat Controls	102
Tekmark Australia	64
Telelink	62
Temwell Corporation	43
Tenrod	13
Terry's Transistors	102
Test Equipment Solutions	62
Trio Smartcal	63
Truscotts Electronic World	102
Wagner Electronics	47
Wifi Products	63
Wiltronics	8
Worldwide Elect. Components	112

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